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This Draft EIS addresses proposed wastewater facilities for the Mammoth Cave Area cities of Horse Cave, Cave City, Park City and Munfordville, Kentucky and the Mammoth Cave National Park. Eight wastewater management alternatives have been evaluated with particular attention to the sensitivity of the cave environment to wastewater discharges, the resource value and importance of the caves, the complexity of the area's subsurface hydrology and the financial impacts of the alternatives on the communities.

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Environmental Impact Statement

Draft

Mammoth Cave Area, Kentucky

Alternatives Development Technical Reference Document

Vol. II

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MAMMOTH CAVE AREA, KENTUCKY

201 FACILITIES PLAN

ENVIRONMENTAL IMPACT STATEMENT

ALTERNATIVES DEVELOPMENT TECHNICAL REFERENCE DOCUMENT

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION IV

ATLANTA, GEORGIA 30365

II-i-a

ENVIRONMENTAL IMPACT STATEMENT
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PART A

INTRODUCTION

1. REVIEW OF THE PROBLEM

In 1976 the Division of Water Quality, Kentucky Department of Natural Resources and Environmental Protection delineated the study area as a 201 facilities planning area. The 201 study area was to include the municipalities of Cave City, Horse Cave, Munfordville and Park City. These municipalities entered into an interlocal agreement, with the Barren River Area Development District providing coordination and management of the 201 study. Subsequent to this local arrangement, an application was made to EPA for funding of the 201 study. Because of the unique geologic conditions within the study area and potential environmental sensitivities and impacts, EPA decided that an Environmental Impact Statement would be prepared in conjunction with the 201 Facilities Plan. Campbell Wallace Consulting Engineers were retained by local communities to perform the 201 Facilities Plan and Gannett Fleming Corddry and Carpenter, Inc. were retained by EPA to perform the EIS. Shortly after the 201 study area delineation, the National Park Service requested that Mammoth Cave National Park also be included within the 201 Facilities Planning Area. Subsequent to this request, the study area was enlarged to include Mammoth Cave National Park.

The purpose of the 201 Facilities Plan is to review the existing treatment facilities in Cave City, Horse Cave and Munfordville. These facilities were constructed in the 1960's and in the cases of Cave City and Horse Cave the treatment facilities are not meeting the standards of secondary treatment as stated in P.L. 96-500, the Federal Water Pollution Control Act Amendments. In addition, the 201 Facilities Plan is to review the potential for extending sewer service to Park City and other outlying areas.

Because of the geological conditions in the area and the current methods of wastewater disposal, it was determined by EPA that an EIS be conducted in conjunction with the 201 Facilities Plan. The study area occupies a large portion of the area known as the Central Kentucky Karst. The Central Kentucky Karst is part of the Karsted belt of the Mississippian carbonate rocks that extends north into Indiana, south into Tennessee and west to the Cumberland River. The area is characterized by rolling topography packed with thousands of sinkholes. There are few surface streams in the area because they all enter the underground geological system as they enter the Sinkhole Plain.

The most important scenic, recreational, and wilderness resources of the Central Kentucky Karst is its caves. The Flint Mammoth System is the largest cave system in the world. There are many other caves in the area, both large and small that are significant scenic and recreational resources. Because caves are limited in size and because the natural processes of oxidation, bacterial action and decay that serve to restore surface environments operate very slowly or not at all in the cave, the cave environment is very sensitive to intrusion of pollutants from the surface. Threats to caves include: (1) loss of scenic value due to contamination of the cave air or streams by pollutants; (2) damage to aquatic and terrestrial life forms; (3) damage to mineral deposits and other special features; (4) potential loss of significant water supplies.

Since the caves in the study area, especially the Flint Mammoth System, are an important natural resource, it is vital that sources of pollution be prevented from entering the system or, in the caves that are already polluted, to remove the sources of pollution. This is the major intent of both the 201 Facilities Plan and the EIS.

The major pollution problem in the area occurs in the Hidden River Cave in Horse Cave. This cave system receives effluent from the Horse Cave Wastewater Treatment Plant. Plant performance has been very unsatisfactory because of untreated wastewater from several industries. These industrial discharges have upset the biological wastewater treatment processes and therefore have resulted in very poor quality effluent being discharged into the Hidden River Cave system. In addition, the Cave City wastewater treatment plant also discharges a poor quality effluent into the Hidden River Cave system. However, it is estimated that the BOD_5 wasteload contributed by the Cave City plant is only approximately 18 percent of that discharged by Horse Cave (Appendix II).

The Alternatives Development Technical Reference Document sets forth a range of engineering alternatives that will be further evaluated for their engineering and environmental feasibility. These alternatives are intended to correct the problems in the area associated with both discharges of municipal and industrial wastewaters. The alternatives also provide options for areas such as Park City and other outlying areas which presently do not have central wastewater collection and treatment. From this process of alternatives development, the EIS moves into the evaluation of alternatives.

2. PROJECTED WASTEWATER FLOWS AND LOADINGS

Water consumption projections developed in the Water Supply section of the Environmental Inventory Technical Reference Document provide the basis for wastewater flow projections. It is assumed that wastewater flows are 90% of the water consumption. The assumed difference is due to water consumption which does not result in spent wastewaters discharged to the wastewater collection system (e.g. car washing, lawn watering, cooking, etc.). The only data available for any population center in the study area to check this assumption are Cave City's metered consumption and wastewater flow records for the months April to September, November and December, 1977. These data tend to substantiate the 90% assumption since during these months wastewater flows averaged approximately 87% of metered water consumption by customers served by the wastewater collection system. It is estimated that this 90% factor is not only applicable for estimating wastewater flows in the residential/commercial communities of Cave City, Park City, Munfordville and Horse Cave, but is also useful for estimating industrial wastewater flows in Horse Cave and those wastewater flows associated with water consumption in the National Park.

Infiltration/inflow (I/I) is generally a factor in projecting wastewater flows. However, I/I is not considered to significantly affect wastewater design flows for Cave City, Horse Cave or Mammoth Cave National Park. This is because process design is to be based on projected average flows and loadings for the peak month during the summer tourist season when infiltration/inflow in the study area is considered to be negligible for all practical purposes. Since Park City has no existing sewerage, and since future wastewater flows are expected to also be seasonal, I/I considerations are again not considered applicable. However, in Munfordville there are no major seasonal variations in wastewaters and I/I must be considered. Based on the limited data presented in the 201 Facilities Plan draft and a flow measurement performed by the Kentucky Division of Water Quality in August, 1977, it appears that Munfordville may have some infiltration/inflow problems during the winter months. Combined I/I may be as high as 40,000 gpd. In addition, infiltration averages approximately 15,000 - 20,000 gpd during winter months (Table II-1). These flows are within acceptable I/I limits established by EPA but are significant for a plant designed for 150,000 gpd and should be included with wastewater flow projections. Original flow projections for Munfordville, as developed in Table I-51 of the Environmental Inventory Technical Reference Document, should be increased by approximately 30,000 gpd to account for estimated infiltration.

A comparison of the original EIS and 201 Facilities Plan draft wastewater flow projections for each major population center is presented in Table II-2. Since some projections differ significantly (>10%), a final EIS projection is indicated for use in alternatives evaluation. The rationales for selecting the final EIS projections are given below:

Cave City - There is really no significant difference between the two projections. The original EIS projection is selected to keep the report as consistent as possible.

TABLE II-1A
MUNFORDVILLE INFILTRATION/INFLOW ANALYSIS

Data and Analysis from Exhibit IIB-12 of 201 Facilities Plan*:

Period	Daily Average Flow (gpd)	Minimum Day (gpd)	Maximum Day (gpd)	Excess Max. Over Average (gpd)
December 1977	83,771	72,520	104,730	20,959
January 1978	80,721	68,050	105,640	24,919
February 1978	79,247	70,080	93,640	14,393
March 1978	76,735	73,210	84,100	3,525
April 1978	79,534	74,850	81,000	1,466

Sewer Customers = 300
Average Wastewater Flow = 80,002 gpd
Average Wastewater Flow/Connection = 266 gpd/connection

Inch Miles of Pipe = 37.75
Allowable Infiltration
37.75 X 1,500 GPD/inch mile = 56,625 gpd

*Mammoth Cave Area 201 Facilities Plan draft
EPA Project No. C210576010

TABLE II-1B
EIS ANALYSIS - LIMITED DATA ESTIMATE OF POSSIBLE MUNFORDVILLE I/I

August 3-4 Recorded Flow - 0.063 mgd (Ky. Division of Water Quality)
Assume this represents base flow during dry summer months

Therefore:

Average Infiltration Estimate for December, 1977 = 83,771 gpd - 63,000 gpd
= Approximately 20,000 gpd

Combined I/I Maximum Day, January 1978 = 105,640 gpd - 63,000 gpd
= Approximately 43,000 gpd

TABLE II-2
PROJECTED DESIGN WASTEWATER FLOWS FOR
MAMMOTH CAVE STUDY AREA POPULATION CENTERS

Municipality	Design Year	EIS* Projection (mgd)	201 Facilities Plan Projection (mgd)	Final EIS Projection (mgd)
Cave City	2000	0.37	0.398	0.37 (Less than 10% difference)
Horse Cave	2000	0.41	0.527	0.53
Park City	2000	0.08	0.06	0.08
Munfordville	2000	0.15**	0.164	0.15 (Less than 10% difference)
National Park				
Staging Area	2000	0.08	0.06	0.08
Historic Entrance (Concessions, campground and residential area)	2000	0.04	0.08	0.04

*Projections given in Table I-51 of Environmental Inventory. Peak season average day (except Munfordville).

**Wastewater flow differs from Table I-51 due to additional 30,000 gpd allowance for I/I.

Horse Cave - The 201 Facilities Plan projection is significantly larger than the original EIS projection. This is because the original EIS projects Ken Dec water use reductions of 40%. This is not considered to be practical at the present since there is no commitment from Ken Dec. Therefore, the 201 projection is selected. However, letters of intent agreements must be obtained by Horse Cave, as part of the 201 process, to establish the capacity to which Ken Dec will be committed.

Park City - The original EIS projection is about 33% larger than the 201 projection. It does not appear that the 201 projection accounts for the peak seasonal flows in Park City due to the expected tourist population increase associated with the construction of the new National Park staging area near Chaumont.

Munfordville - The 201 projection is slightly higher apparently because more customers are anticipated than indicated by EIS estimates. However, the difference is considered to be insignificant (<10%). The original EIS estimate (adjusted for I/I as described above) is selected to maintain consistency.

National Park - Although the total projected wastewater flows for the National Park are comparable, 0.14 mgd for the 201 projection and 0.12 mgd for the original EIS estimate, the distribution of flows to the Staging Area and Historic Entrance Areas is significantly different. The small difference in total flow projections is due primarily to the fact that EIS estimates are based on 90% of the estimated water consumption.

The original EIS flow distribution estimate is based on a detailed breakdown of National Park water consumption during the peak month of cave visitation recorded at Mammoth Cave National Park (August 1970). Water consumption figures from this month indicate that the park concessions facilities used an average of 30,000 gpd. The park concessions will be the major source of wastewater in the Historic Entrance area when the visitors center is moved to the staging area. Additional sources in the area are the campground facilities, employee residences and park administration offices. Wastewater flows from these areas are expected to contribute an additional 10,000 gpd. Wastewater generated at the Historic Entrance is not expected to significantly increase above the August 1970 flow, assuming maximum use of concession facilities. Therefore, the EIS wastewater flow projection is 0.04 mgd, only one-half that projected by the 201 Plan. For this reason, the original EIS distribution estimates are selected as the final EIS flow projections for the Staging Area and Historic Entrance.

Estimated BOD_5 concentrations of wastewaters generated in the study area are provided in the 201 Facilities Plan draft. These estimates are developed using data from existing wastewater treatment facilities and generally appear to be acceptable for use in projecting design year wasteloads. However, Park City estimated waste strength appears to be slightly high at 359 ppm. Since there is no existing data for Park City wastewater, the BOD_5 concentration projected for future Park City wastewaters is considered to be best approximated by that of Cave City. This is because wastewaters

from anticipated tourist-related development in Park City are expected to be similar to those in Cave City. Projected BOD_5 loadings for all the major population centers are presented in Table II-3.

TABLE II-3
BOD_5 WASTE LOAD PROJECTIONS

Population Center	*BOD_5 Concentration Estimates (ppm)	Design Flow (mgd)	Estimated Daily BOD_5 Load Projections Pounds BOD_5/day
Munfordville	320	0.15	400
Horse Cave	340	0.53	1500
Cave City	320	0.37	990
Park City	320	0.08	210
Staging Area	250	0.08	170
Historic Entrance	250	0.04	80

*All BOD_5 concentrations except for Park City are based on the 201 Plan draft estimates, rounded to the nearest ten.

PART B

IDENTIFICATION OF WASTEWATER MANAGEMENT ALTERNATIVES

1. INTRODUCTION

The development of alternatives for wastewater treatment in the Mammoth Cave area is accomplished in two phases. The first consists of developing alternative wastewater service configurations. A service configuration is a distinct plan for providing wastewater treatment and disposal services to each major population center in the study area, either by local treatment/disposal, or joint treatment/disposal by two or more population centers. It does not include options for the actual treatment and disposal methods but rather service conveyance configurations and disposal locations. For example, providing local treatment and disposal at each population center is one service configuration while other service configurations include different combinations of local and joint treatment/disposal to serve the population centers.

The development of these service configuration alternatives first involves determining the major population centers in the study area and then identifying various combinations of two or more population centers for which joint treatment/disposal appears to have economic and/or environmental advantages over local treatment/disposal and, therefore, requires further evaluation. Finally, the alternative service configurations for the area are established by the combination of local and joint wastewater treatment/disposal service schemes.

The second phase of alternatives development involves screening various wastewater treatment/disposal techniques for applicability in the Mammoth Cave study area and generating treatment/disposal options for local treatment/disposal at each population center as well as for each joint treatment combination (joint treatment/disposal) which appears in the service configuration alternatives. These treatment/disposal options provide only for the level of treatment (e.g. secondary or advanced secondary) and for the method of disposal (e.g. discharge to surface waters or spray irrigation).

This two phase approach is intended to provide increased understanding of the alternatives development method as well as ease of evaluation. The cost-effective evaluation of individual local and joint wastewater treatment/disposal options is completed as a first evaluation step. Recommended cost-effective options are incorporated into the service configurations to formulate a limit of number of wastewater mangement alternatives for final evaluation.

2. ALTERNATIVE WASTEWATER SERVICE CONFIGURATIONS

To develop conveyance and treatment alternatives it is necessary to first establish the major wastewater sources to be considered in development of these alternatives.

There are presently five major "population centers" (wastewater sources) in the Mammoth Cave, Kentucky 201 study area, Mammoth Cave National Park, Park City, Cave City, Horse Cave and Munfordville. However, with the construction of the planned visitor's center and staging area near Chaumont, the National Park "population" will be divided between the Staging Area and the Historic Entrance area. The Staging Area, located at the Park boundary, will be the site of new visitor's center facilities. Still located at the Historic Entrance area will be the campgrounds, park concessions, employee residences and park administration building. According to Mammoth Cave National Park authorities, any conveyance of wastewater through the National Park is unacceptable, thus, isolating the Historic Entrance area and eliminating the possibility of any joint treatment/disposal options involving the Historic Entrance area. Furthermore, all wastewater services for the Historic Entrance area are to be handled independently by the National Park Service. For these reasons, only the Staging Area (National Park) is considered as one of the five major population centers for the purposes of alternatives development.

There are also some small unincorporated residential communities within the 201 study area such as Woodsonville and Rowletts. Rowletts is a small community located approximately midway between Horse Cave and Munfordville. According to the 201 Facilities Plan draft, collection facilities are not practical in this area. Findings of this EIS concur. However, the 201 draft suggests that Woodsonville be considered for future wastewater facilities planning. Presently there are about 35 to 40 homes in the immediate area of Woodsonville, most of which were constructed since 1972. In addition, the Hart County High School is located in Woodsonville. Residents in the area use on-lot systems for wastewater treatment and disposal with no apparent major problems according to the Hart County Health Department.* The high school operates a 6,000 gpd extended aeration wastewater treatment system with discharge to the subsurface via sinkholes. Because the population density of the area is so low and there appear to be no serious on-lot disposal problems, and since most of the development in Woodsonville has occurred since 1972, it is doubtful whether collection facilities for Woodsonville could be funded by the EPA. This conclusion is based on provisions of EPA Program Requirements Memorandum No. 78-9, Funding of Sewage Collection System Projects. Furthermore, since there is such a small number of homes in the Woodsonville area, it appears that construction of collection facilities with only local funds would be economically infeasible. For these reasons, Woodsonville is not considered as a population center in developing alternatives for wastewater conveyance and treatment.

During the summer months, motels and campgrounds located outside the municipalities house additional populations. These facilities treat and dispose wastewater on site. Many operate package wastewater treatment facilities which discharge to lagoons or directly to the subsurface via sinkholes (Table I-44, pg. I-145). Others operate septic tank-absorption field systems. As

* Personal communication with Mr. Barry Wood, Hart County Health Department

indicated by the 201 consultant, expansion and improvement of campgrounds may generate much larger wastewater loads in the future which may significantly impact water quality in the area. However, at present, there are no reports of major problems with these facilities.

Campgrounds, motels and other recreational facilities scattered throughout the area are generally not considered to significantly affect wastewater management alternatives development and evaluation for the following reasons: 1) most of the facilities are located well outside municipal sewerage service areas, 2) in most cases, wastewater loads are presently small compared to proposed municipal design flows and could be accommodated, 3) the present systems are assumed to be operating satisfactorily according to the 201 consultant. However, tourist industry related development (campgrounds, motels, gift shops etc.) along Route 70 west of the I-65 Cave City intercharge to the National Park entrance near Chaumont appears to represent a significant source of wastewater. (This includes the Jellystone Park campground which is to receive Cave City wastewater collection services under the 201 Plan recommendations). Even though the area is not within any of the municipal population centers' boundaries, it is included in the development of wastewater treatment and disposal options primarily because of the potential adverse impacts to the Mammoth Cave system from the continued use of individual subsurface wastewater disposal systems. (It has been demonstrated by Dr. James Quinlan that subsurface drainage, from this area flows into the Echo-Styx basin in Mammoth Cave National Park.) Based on present estimated water consumption and development projections, the volume of wastewater resulting from Rt. 70 development during the summer months is projected to be 50,000 gpd. (Appendix II) for the purposes of developing wastewater treatment/disposal options that include the area.

Other small wastewater treatment facilities serving schools or businesses located in existing or proposed municipal sewerage service areas are not considered to significantly impact alternatives development. This is primarily because these flows are relatively small and/or are already included in domestic wastewater flow projections.

Though there are many smaller wastewater sources in the study area, the five population centers plus the Rt. 70 development area, as earlier described, are the only ones to be considered in developing wastewater management alternatives. Local wastewater treatment and disposal is first considered for each of population centers. They are as follows:

Munfordville
Horse Cave
Cave City
Park City
Staging area (Nat. Park)

Although wastewater treatment and disposal in the study area is presently handled locally, economic and/or environmental considerations may necessitate combining wastewaters from two or more population centers for joint treatment and disposal. There are several joint treatment/disposal configurations for for study area population centers that, because of the potential economic or environmental advantages, require further evaluation. These are presented and described in Table II-4.

TABLE II-4 COMBINATIONS OF POPULATION CENTERS FOR JOINT TREATMENT/DISPOSAL TO BE CONSIDERED FOR FURTHER EVALUATION

Population Centers Combinations for Joint Treatment/Disposal	Joint Treatment/Disposal Combination Identification	Conveyance Facilities and Discharge Location	Major Consideration(s) for Further Evaluation
Staging Area Park City Cave City Horse Cave	SA-PC-CC-HC	Conveyance facilities: Staging area to Park City to Cave City to Horse Cave Treatment and discharge to Green River	Environmental consideration of eliminating all subsurface discharge
Park City Staging Area Cave City Horse Cave	PC-SA-CC-HC	Conveyance facilities: Park City to Staging Area to Cave City to Horse Cave Treatment and discharge to the Green River	Environmental considerations of eliminating all subsurface discharges including those resulting from disposal systems serving the Rt. 70 development area where subsurface drainage enters Mammoth Cave National Park Cave systems
Park City Cave City Horse Cave	PC-CC-HC	Conveyance facilities: Park City to Cave City to Horse Cave Treatment and discharge to Green River	Environmental consideration of eliminating subsurface discharge
Staging Area Cave City Horse Cave	SA-CC-HC	Conveyance facilities: Staging Area to Cave City to Horse Cave	Environmental considerations of eliminating subsurface discharges from Cave City and Horse Cave as well as those from disposal systems serving the Rt. 70 development where subsurface drainage enters Mammoth Cave National Park systems
Cave City Horse Cave	CC-HC	Conveyance facilities: Cave City to Horse Cave Treatment and discharge to subsurface, Green River or land application system	Possible economies of scale in treatment plant construction and operation; Environmental consideration of eliminating subsurface discharges (Green River disposal)
Park City Cave City	PC-CC	Conveyance facilities: Park City to Cave City Treatment and discharge to subsurface at existing Cave City site or treatment and land application	Environmental consideration of eliminating potential Park City discharges to Echo-Styx groundwater basin
Staging Area Cave City	SA-CC	Conveyance facilities: Staging Area to Cave City (via Rt. 70) Treatment and land application	Environmental consideration of providing wastewater services to the Rt. 70 development area eliminating drainage from subsurface disposal systems from the area entering the National Park cave systems

Munfordville is the only population center not considered as a part of any joint treatment/disposal scheme. This is because 1) the Munfordville wastewater treatment facility is considered adequate, with certain relatively limited improvements, to serve the needs of the Munfordville area, 2) conveyance of wastewaters to Munfordville for discharge to the Green River instead of to a point closer to Horse Cave would require several additional miles of force main, probably off-setting any economies of scale realized by including the Munfordville plant in a regional facility (this is also indicated by the 201 consultant's analysis), and 3) the present Munfordville treatment plant site is unsuitable for a regional facility, thus requiring additional conveyance of Munfordville wastewaters to a new site.

Given the joint treatment/disposal combinations to be considered, as well as local treatment/disposal, there are several possible alternative wastewater service configurations combining local and joint treatment/disposal approaches to wastewater management. Wastewater service configuration alternatives for the study area are presented in Figures II-1 to II-8.

WASTEWATER SERVICE CONFIGURATION
ALTERNATIVE NO. 1

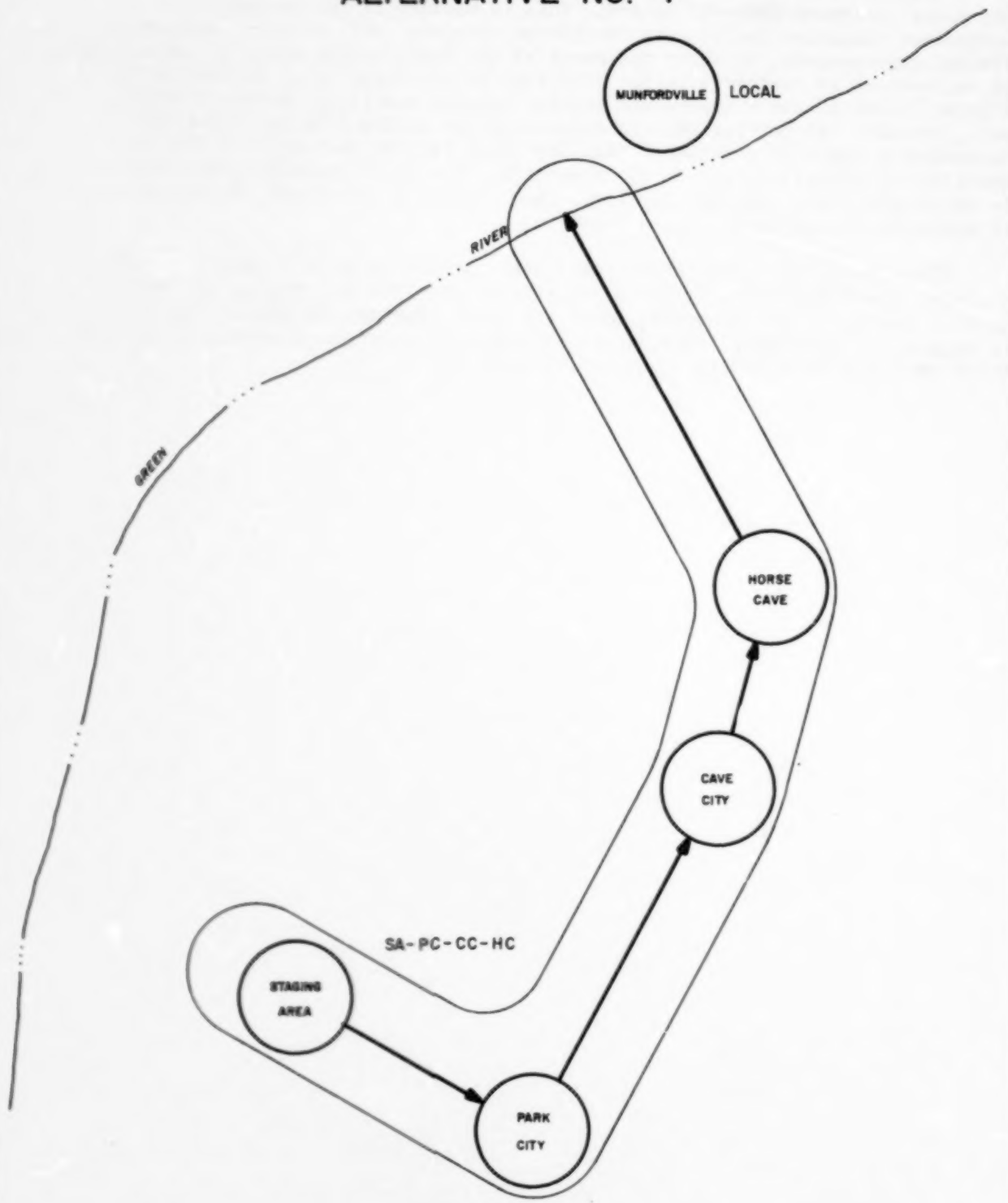


FIGURE II-1

WASTEWATER SERVICE CONFIGURATION
ALTERNATIVE NO. 2

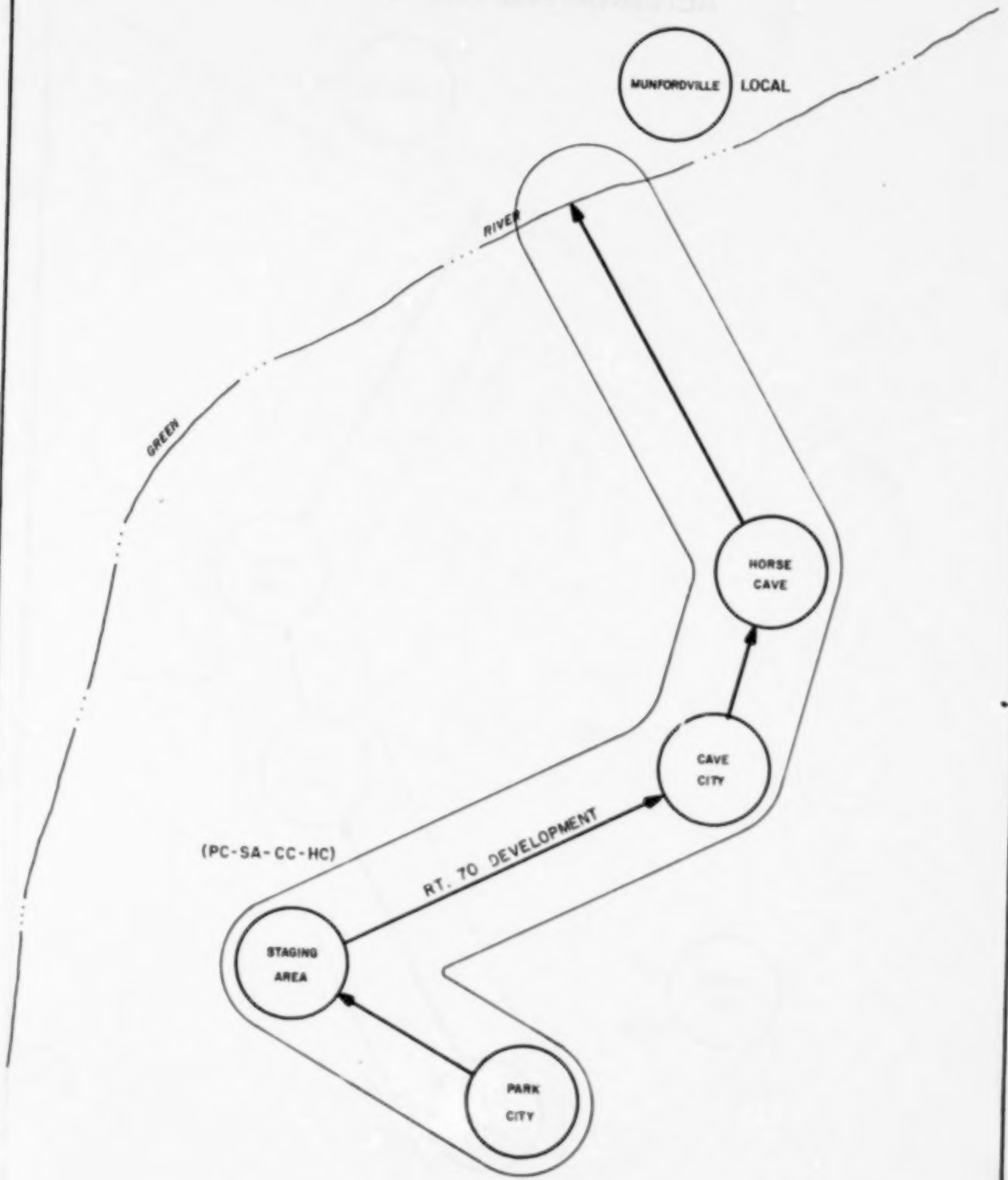


FIGURE II-2

WASTEWATER SERVICE CONFIGURATION
ALTERNATIVE NO. 3

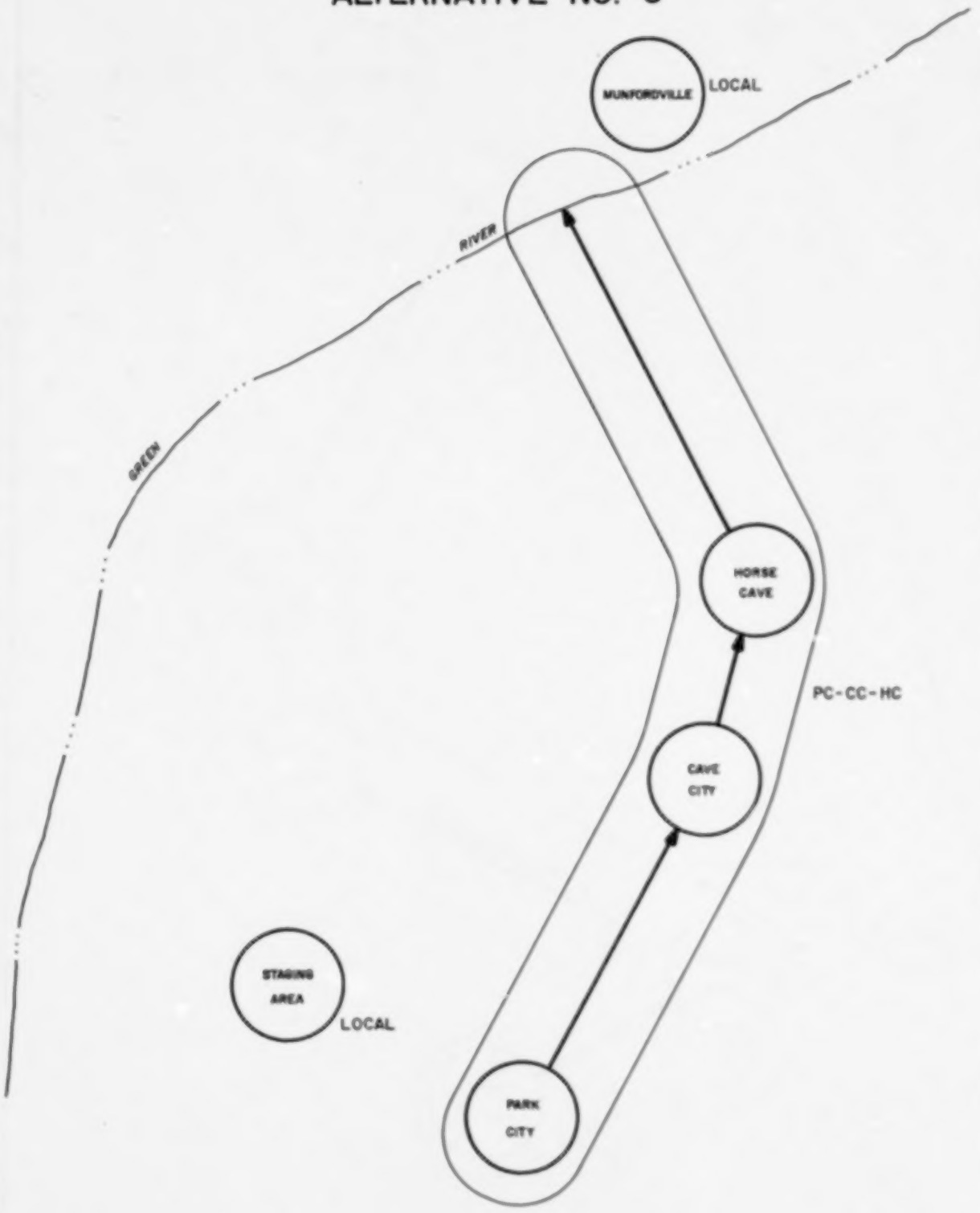


FIGURE II-3

WASTEWATER SERVICE CONFIGURATION
ALTERNATIVE NO. 4

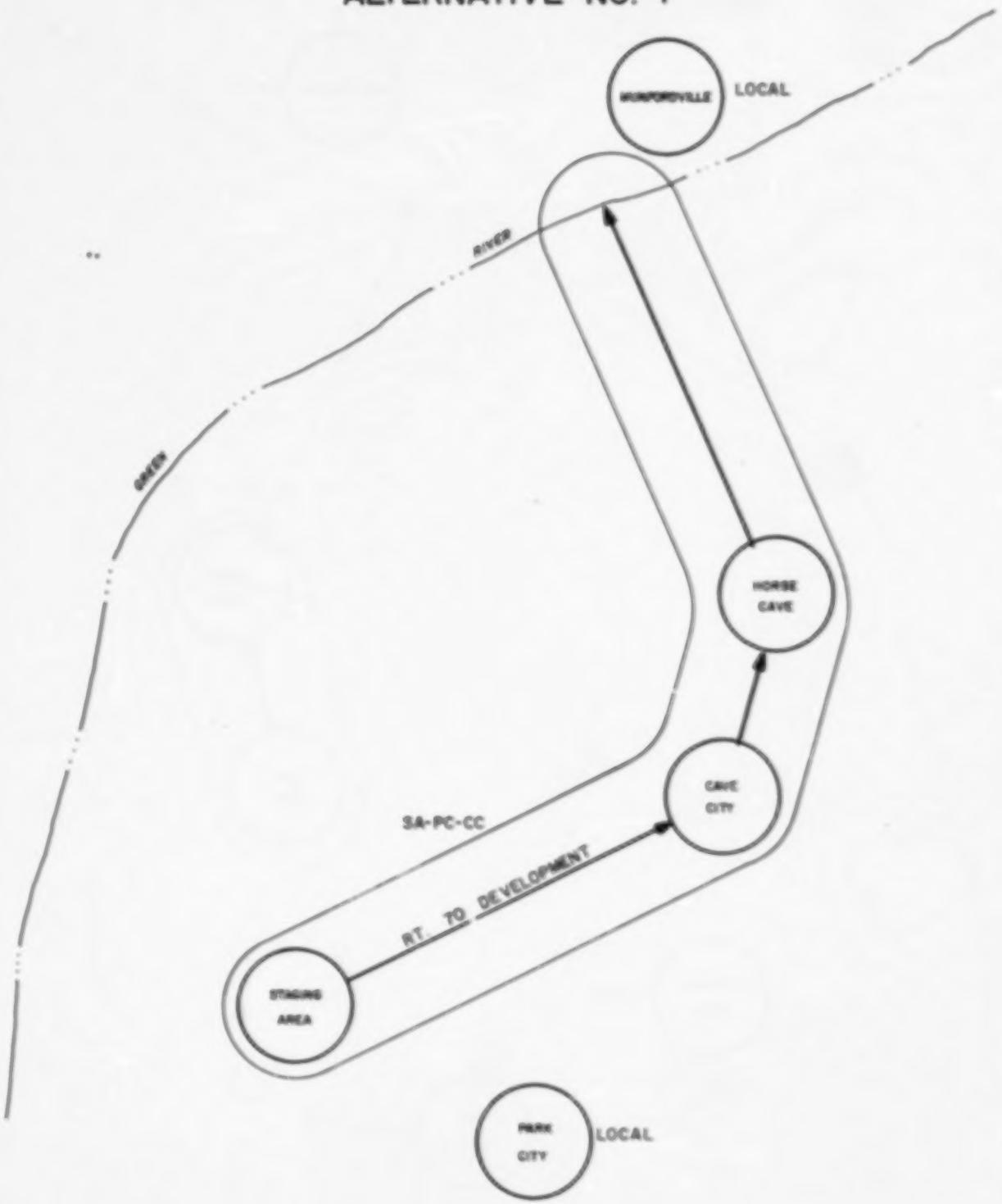


FIGURE II-4

WASTEWATER SERVICE CONFIGURATION
ALTERNATIVE NO. 5

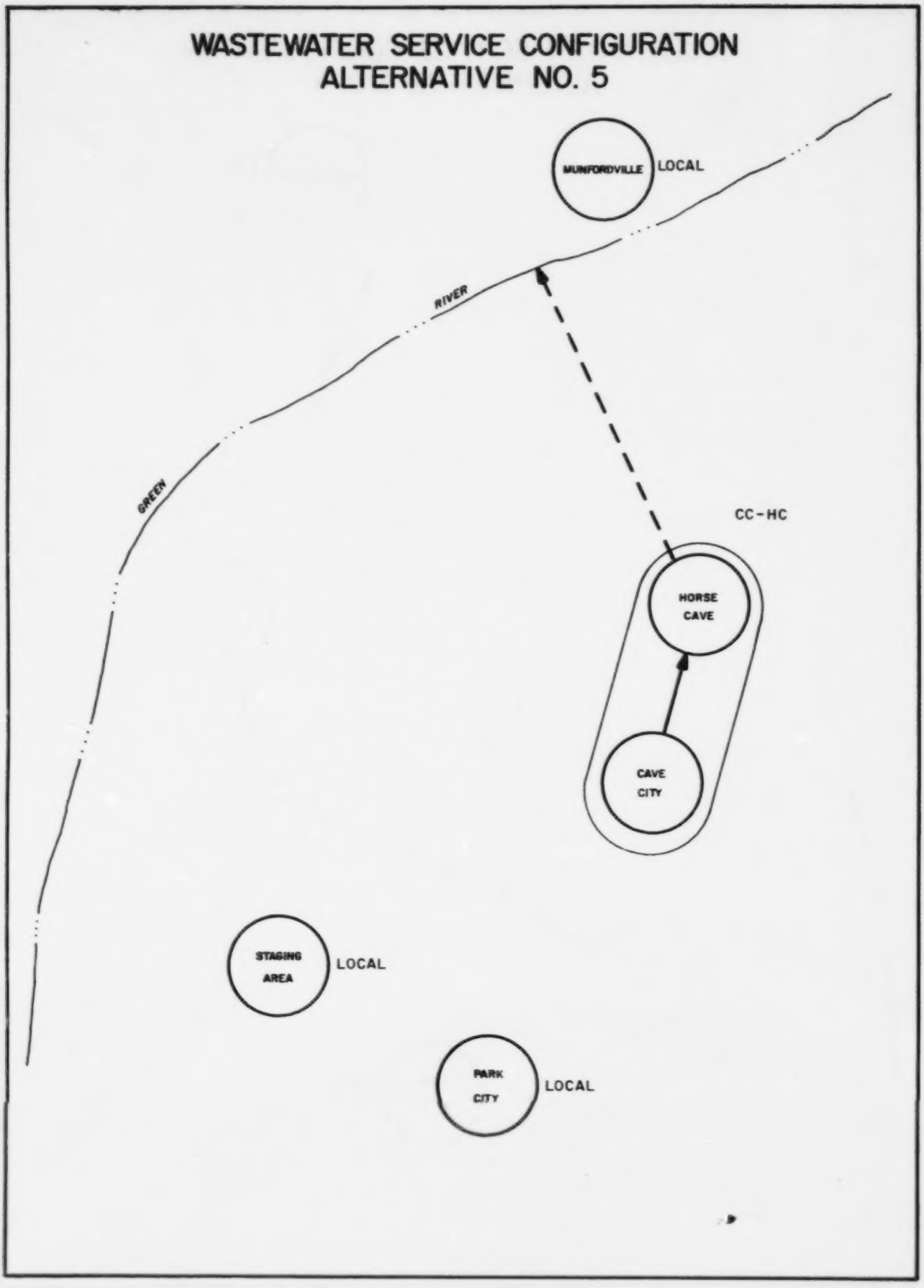


FIGURE II-5

WASTEWATER SERVICE CONFIGURATION
ALTERNATIVE NO. 6

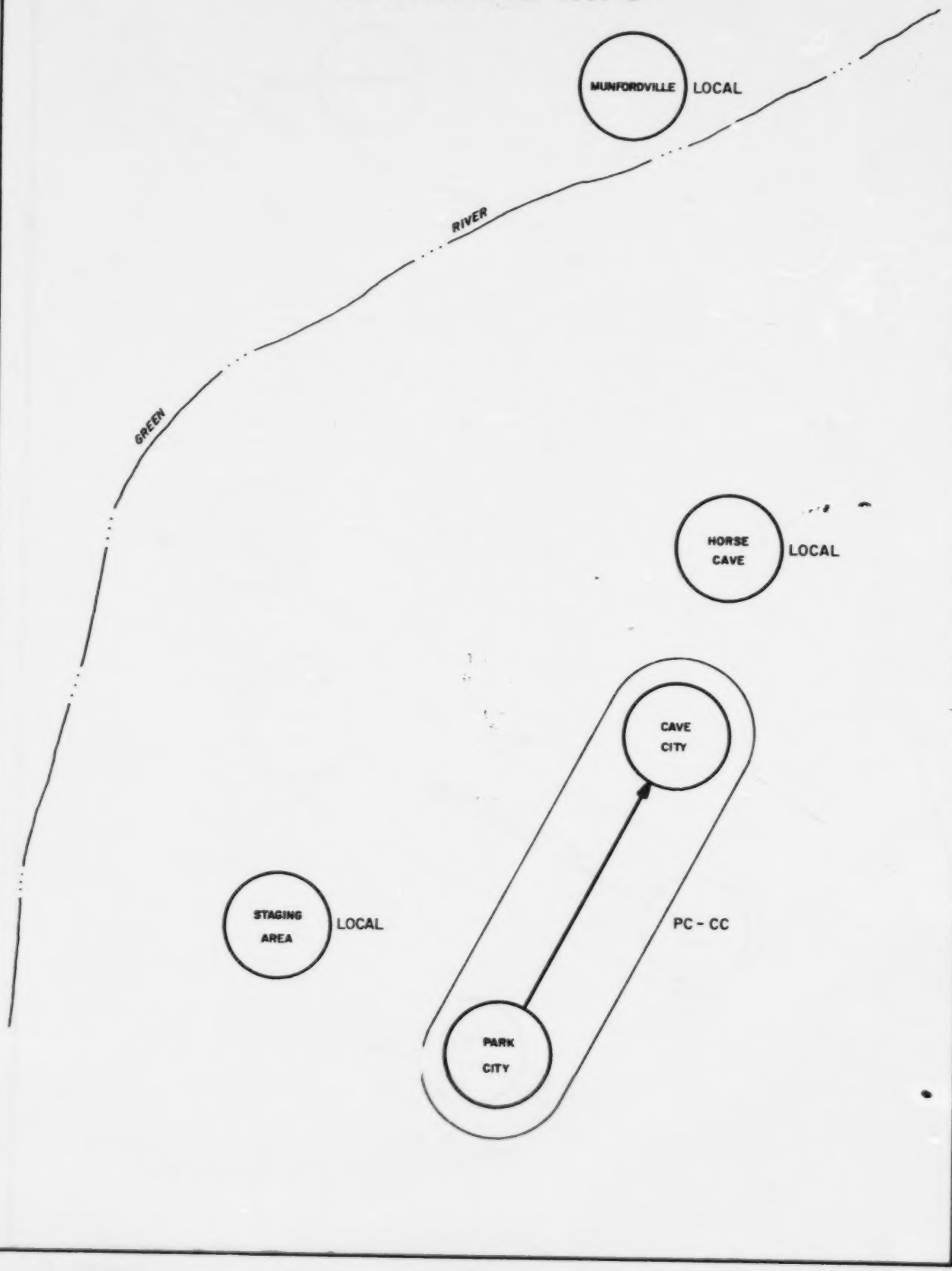


FIGURE II-6

WASTEWATER SERVICE CONFIGURATION
ALTERNATIVE NO. 7

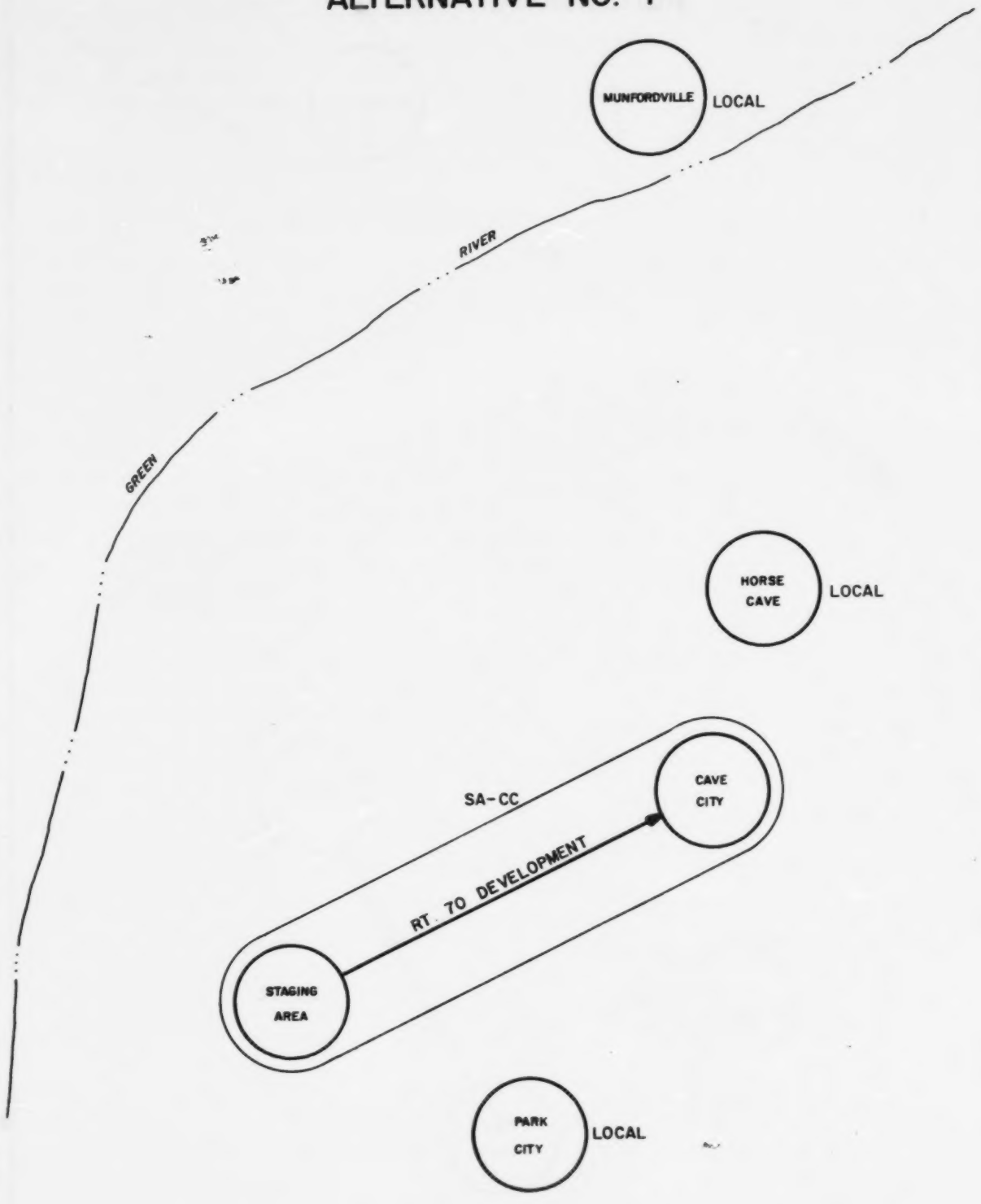


FIGURE II-7

WASTEWATER SERVICE CONFIGURATION
ALTERNATIVE NO. 8

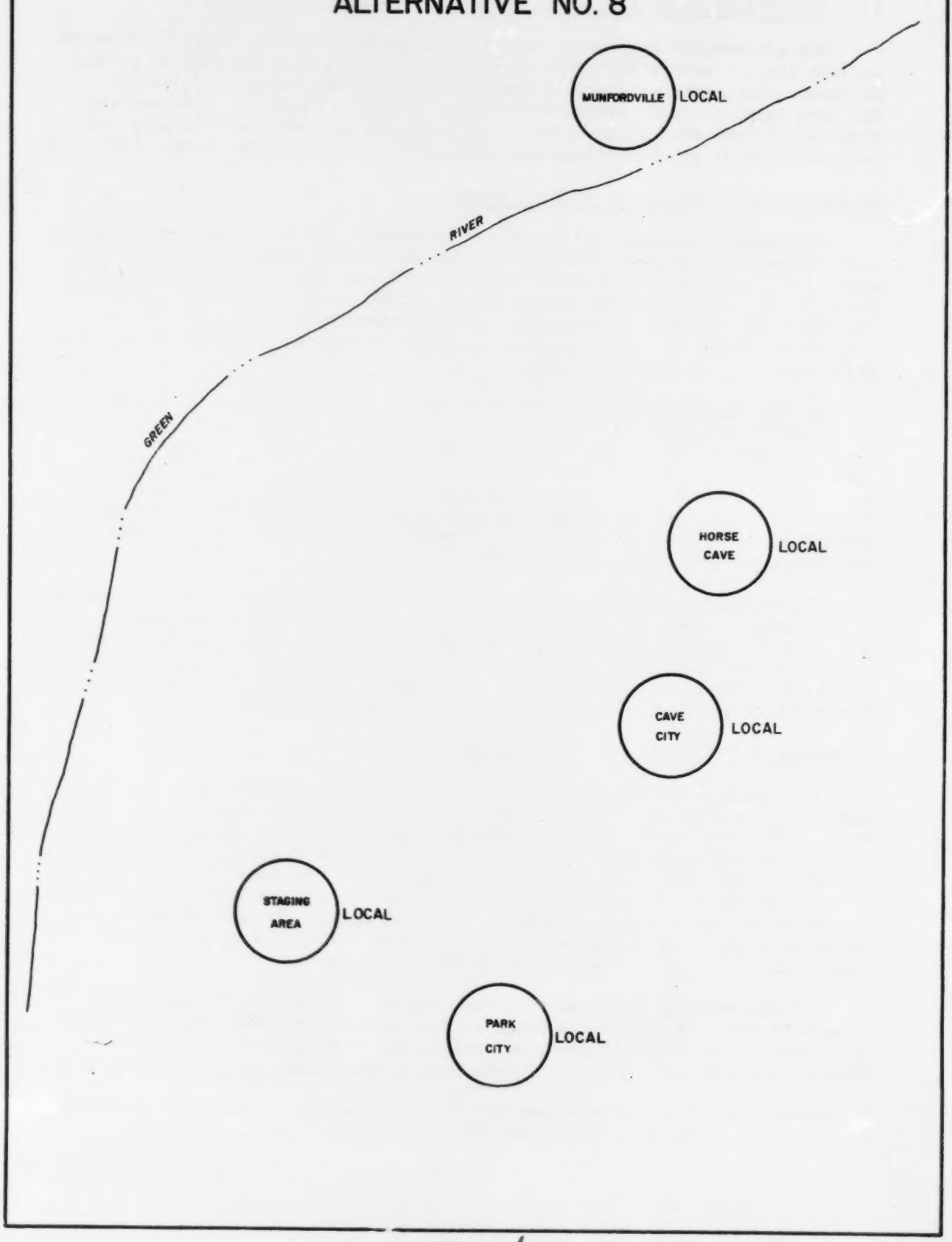


FIGURE II-8

3. IDENTIFICATION OF APPLICABLE TREATMENT AND DISPOSAL METHODS

The alternative wastewater service configurations to be further evaluated include local treatment/disposal at each population center as well as several different combinations of population centers for joint treatment/disposal. For each local or joint treatment/disposal scheme, alternative treatment and disposal methods must be developed. In this section, various treatment and disposal methods are identified and evaluated for application in the study area.

Treatment and Discharge to Surface Waters

Wastewater treatment and discharge to surface waters is the most commonly used wastewater management technique. It consists of treating wastewater by a combination of physical, chemical and/or biological processes and discharging the effluent to a receiving stream via an outfall. This method of wastewater treatment and disposal is presently used by Mammoth Cave National Park and the city of Munfordville. Both operate secondary biological treatment facilities which discharge to the Green River.

In the Mammoth Cave Area, the Green River is the only surface stream large enough to assimilate wastewater. The segment of the Green River which flows through the study area has an estimated 7-day, 10-year low flow of approximately 160 cfs (103 mgd) and is effluent limited. "Effluent limited" means that wastewater treatment plant effluents which are discharged to the Green River must meet secondary treatment levels as defined by EPA (30 mg/l BOD and 30 mg/l TSS). This level of treatment is considered adequate to protect water quality in the Green River.

The assimilative capacity of the Green River is large enough to accomodate a substantial volume of secondary effluent; therefore, there are several local and joint treatment/disposal alternatives which can be developed involving secondary treatment facilities and discharge to the Green River. Potential discharge points to be considered in developing wastewater treatment/disposal options are Munfordville and downstream from Munfordville near Lawler Bend.

Treatment and Discharge to the Groundwater

The groundwater regime in the Mammoth Cave area includes many freeflowing subsurface streams which have a hydrological demonstrable nexus to the Green River. That is, free flowing groundwaters which have been shown to be tributary streams of surface waters. Wastewater treatment and discharge to these waters is, therefore, controlled by regulations governing treatment and discharge to surface waters as specified by 40 CFR 125.1 (P)*. Consequently, any alternatives involving treatment and discharge to these subsurface streams are developed based on maintaining the water quality criteria associated with the Aquatic Life classification as directed by 40 CFR 120.21 (b)*.

In the Mammoth Cave Area there are two existing municipal wastewater treatment facilities that discharge to free flowing groundwaters. The Horse Cave wastewater treatment plant discharges to the Hidden River Cave South Branch, the Cave City plant to a tributary of the Hidden River Cave East Branch.

* Regulations cited in Environmental Inventory Technical Reference Document, Section 9, Subsurface Water Resources, Groundwater Quality Criteria.

Since the South Branch has little or no assimilative capacity during base flow conditions (base flow less than 1 cfs), however, the present Horse Cave discharge point is not acceptable for future wastewater discharges.

Although there are free-flowing groundwaters in the Park City area, treatment and subsurface discharge at Park City is not considered acceptable since the exact location of the stream(s) is unknown and because subsurface drainage from the area flows to Mammoth Cave National Park. There are, therefore, only two locations in the study area considered for subsurface discharge: 1) the existing Cave City discharge point tributary to Hidden River Cave East Branch; and 2) Hidden River Cave downstream from the confluence of the East and South branches. The existing Cave City discharge point is considered because results from limited base flow sampling do not indicate significant water quality degradation in the East Branch downstream from the Cave City discharge, even though secondary treatment was not being achieved during the sampling period. The conditions in groundwaters between the discharge and the East Branch sampling point in Hidden River Cave, however, are unknown. A discharge point at Horse Cave located downstream from the confluence of the East and South branches is considered since an estimated flow of 7 cfs (Quinlan-Rowe)** provides a dilution ratio of approximately 8.5 for the projected Horse Cave year 2000 design flow. This should provide some assimilative capacity for discharge of adequately treated wastewater.

Wastewater treatment/disposal options that include treatment and subsurface discharge cannot be fully developed without treatment requirements. At the present time, the State of Kentucky has not developed effluent limits for subsurface discharges in the Mammoth Cave area. In the absence of such effluent limits, recommended treatment requirements are provided as part of this EIS and are based primarily maintaining the dissolved oxygen water quality criterion associated with the aquatic life classification, 5 mg/l.

The recommended level of treatment for subsurface discharge to the Hidden River groundwater basin at either Horse Cave or Cave City is advanced secondary. Advanced secondary treatment is defined as any treatment level greater than secondary (30 mg/l BOD_5 and 30 mg/l total suspended solids). For the purposes of development of treatment options, advanced secondary refers to 10-20 mg/l BOD_5 and 20-30 mg/l TSS. There is no data with which to model assimilative capacity; however, based on crude assimilative capacity and time-of-travel estimates (Appendix II), it appears that this level of treatment, provided consistently, will protect water quality (D.O. $\geq$5 mg/l) in Hidden River Cave. Although this is not certain, it appears to be unwarranted to require any higher level of treatment for discharge to Hidden River Cave until the stream reaches equilibrium after improved treatment. This is because there are no data to indicate any more strigent requirements are necessary and advanced secondary treatment will only serve to substantially improve water quality. Only when the effects of advanced secondary treatment are determined, should move advanced treatment be considered.

** Quinlan, J. F. and Rowe, D. R., Hydrology and Water Quality in the Central Kentucky Karst: Phase II Part A, University of Kentucky Water Resources Research Institute, Lexington, KY. 1978

Treatment and Land Application

Land application of treated wastewater provides for further removal or reduction of pollutants by physical and/or biological processes which occur in the soils. The successful operation of a land application system is site dependent. The factors which must be considered include soil structure and chemistry, topography, geology, hydrology, climate and vegetation. The land-treated wastewater is removed from the soil by evapo-transpiration, is returned to surface streams by runoff or percolates downward through the soil to the groundwater.

The most widely considered land application techniques are septic tank/soil absorption for individual homes or small communities; and spray irrigation, rapid infiltration and overland flow for centralized sewerage systems serving larger populations.

There is potential for using land application techniques for wastewater treatment and disposal in the Mammoth Cave study area. Each of the land application techniques is described below. In addition, the applicability of each technique to meet wastewater treatment needs at the population centers in the study area is assessed.

Septic Tank/Soil Absorption System. Conventional individual on-lot septic tank/soil absorption systems are a viable alternative for the treatment and disposal of wastewater in areas with relatively low population densities and favorable soil, geologic, climatic and hydrologic conditions. Use of conventional septic tank/soil absorption systems are most often limited by one or a combination of the following conditions:

1. Unsuitable soil permeability
2. Shallow depth to bedrock or fragipan
3. Shallow depth to seasonal high water table
4. Excessive slopes

If the limitations are not severe, use of modified septic tank/soil absorption systems may be acceptable. Site modifications may include grading and/or filling, while absorption system modifications may include constructing subsurface sand filters or elevated sand mounds.

Generally, septic tank/soil absorption systems are used with individual on-lot systems. However, in sections of small communities where population densities are too high for individual on-lot systems but other conditions are favorable, community-sized septic tank/soil absorption systems may be feasible. One method of operating this type of system is to convey effluents from individual septic tanks to a central soil absorption system in an adjacent area. Another method is to collect and convey wastewaters to a large, central septic tank and soil absorption system. As in the case of individual on-lot systems, if soil conditions are marginal, modifications may be made to provide for an adequate absorption system.

Soil associations in the Staging Center area are moderately to severely limited for septic tank/soil absorption systems. This is primarily due to the shallow depth to bedrock. Some modifications may be possible to develop an adequate absorption system; however, the estimated volume of wastewater to be treated during peak tourist season (average 80,000 gpd year 2000) is considered too great. However, conditions appear to be suitable for accomodating a smaller volume of treated greywater from hand washing, drinking fountains, clean-up, etc.

The potential for using septic tank/soil absorption systems is probably greatest in Park City. Soil associations in the area are generally adequate and population areas in the center of the town where community systems may be appropriate.

In Munfordville, approximately half of the population uses individual on-lot septic tank/soil absorption systems (with no reports of serious malfunctions) while the remainder of the population is served by the Munfordville sewerage system. Continued use of these on-lot systems may be a viable alternative for providing wastewater treatment and disposal in unsewered areas of Munfordville.

Although soil associations in the Horse Cave and Cave City areas are generally adequate, the use of on-lot systems is not considered to be a practical alternative since population densities are too high. However, future development on the outskirts of these communities could include use of septic tank/soil absorption systems for wastewater treatment and disposal.

Rapid Infiltration. The rapid infiltration technique involves land application of treated wastewater to a relatively high-permeability soil. Most of the applied wastewater percolates rapidly downward, eventually reaching groundwater. Filtration and adsorption in the soils accounts for nearly complete removals of suspended solids, BOD and fecal coliform. This type of land application technique is not well-suited for conditions in the Mammoth Cave area. Generally, the permeability of soils in the Mammoth Cave area is too low. In addition, depths to groundwater or bedrock are too shallow.

Overland Flow. In the overland flow technique, treated wastewater is applied over the upper reaches of sloped terraces and allowed to flow across vegetated surfaces (2-8% slopes) to runoff collection ditches and

is discharged to a receiving stream. Waste constituents are removed by physical, chemical and biological means as the wastewater flows in a thin film over soils which are usually relatively impermeable. Overland flow appears to produce a high quality effluent, with BOD and suspended solids averaging approximately 10 mg/l and ammonia nitrogen less than 1 mg/l (EPA Land Application Manual).

The overland flow land application technique is not considered particularly well-suited for use in the Mammoth Cave area because soils are generally not impermeable and because there are no receiving streams for overland flow discharge. Operation of an overland flow system in the area would probably result in a practical operational mode of slow rate-overland flow since some of the wastewater would percolate to the subsurface because of soil permeability. Drainage from such an overland flow system located in the vicinity of Park City, Cave City or Horse Cave (sinkhole plain area) would enter the subsurface, generally at the base of a sinkhole. Because of the instability of sinkhole soils-rock structure, this method does not appear to be satisfactory. Erosion caused by the drainage system could cause collapse of the sink. Another possibility is that the sink drainage could clog, producing pending of treated wastewater.

The vicinity of the proposed Staging Area is also not considered well-suited for an overland flow system. This is primarily because of the steep slopes in the area. In addition, discharge to the subsurface waters of the National Park is not considered an acceptable alternative.

Slow Rate (spray irrigation). In the slow rate technique, *treated wastewater is applied to a vegetated area where a portion of the water is treated as it percolates slowly through the soil to groundwater and the remainder of the water is removed by evapo-transpiration. In this process much of the nutrients in the wastewater are taken up by the plants. Generally, surface runoff is not allowed. This technique not only provides a high degree of treatment, but also provides for some economic return from crops which may be raised on the irrigation site. Of the three techniques, slow rate (spray irrigation), rapid infiltration and overland flow, only spray irrigation is considered in the development of wastewater treatment disposal options.

Soil conditions in the Horse Cave and Cave City areas generally appear to be adequate to warrant investigating the possibility of using a slow rate land application system to meet wastewater treatment needs at these population centers. Because of the large volume of wastewaters generated in these areas, however, land requirements would be substantial. In addition, unless the treated wastewaters could be discharged to the subsurface during the winter months, the wet weather storage requirements would be a significant cost factor. Year-round slow rate land application is considered to be a possible alternative for Park City since soils are generally suitable and flows much smaller. Potential slow rate

* The assumed pre-application treatment for spray irrigation systems included in treatment/disposal options developed for the Mammoth Cave area is secondary treatment. Although EPA Program Requirements Memorandum (PRM) 79-3 states that a universal requirement of secondary treatment is excessively stringent, secondary treatment is considered necessary in this area to protect subsurface waters from drainage from spray irrigation systems.

land application sites for Horse Cave, Cave City and Park City are indicated in Figures II-9, II-10 and II-11, respectively. These sites are indicated because both soils and slopes appear to be satisfactory based on general soils data and topographical maps (Tables II-5 and II-6). However, site specific inspection is required to make a final determination of site suitability.

Spray irrigation is not considered a viable alternative at the Staging Area primarily due to shallow depths to bedrock. Because the wastewater cannot percolate downward, the soils at the irrigation site would become saturated and destroy the vegetative cover. In turn, the applied wastewater would then appear as surface runoff.

Waterless, Composting Toilets

A composting toilet consists of an impervious container with a sloping bottom and some type of mechanism for allowing the organic wastes to move slowly down the sloping bottom as they are aerobically decomposed. Since the process is well vented and because it is aerobic, it is generally free of offensive odors. The end products are carbon dioxide, and water vapor (both vented), and humus. Because carbon dioxide and water are the main waste products, the volume of humus represents only about 5 to 10 percent of the original waste volume. This humus is generally safe for land spreading, even in vegetable gardens.

Although this approach to waste management is not a practical alternative on a large scale in existing communities, there is one population center in the Mammoth Cave area where composting toilets may prove useful, the Staging Area. Since construction for the center has not begun, composting facilities could be provided at construction, avoiding expensive building alternations. In addition, since the only wastewater generated at the center would result from hand washing, drinking fountains, general clean up, etc., only minimum treatment facilities would be required.

Potential advantages of using this type of system include cost savings, wastewater reduction, and water and energy conservation. For these reasons, the use of compostions toilet at the Staging Area is further evaluated.

Specific Wastewater Treatment/Disposal Options

The preceding general discussions and evaluations of various treatment-disposal methods serve as the basis for developing specific wastewater treatment/disposal options for the major population centers of the study area. These options are presented in Tables II-7 and II-8. Table II-7 contains local treatment/disposal options for each major population center combination indicated in the alternative wastewater service configurations.

For options that include wastewater treatment plant(s), reliability of the treatment facility(s) is specified as part of the option. Reliability is defined by EPA technical bulletin EPA-430-99-74-001 "Design Criteria for Mechanical Electric and Fluid System and Component Reliability" as, "A measurement of the ability of a component or system to perform its designated function without failure". There are three reliability classifications for wastewater treatment plants developed in the EPA bulletin and are based on the consequencies of potential degradation on the receiving waters. No specific requirements for classifying treatment works are given, however, the following suggested guidelines are presented:

MAMMOTH CAVE AREA
201 FACILITIES PLAN

ENVIRONMENTAL IMPACT STATEMENT

POTENTIAL SLOWRATE LAND APPLICATION SITE – HORSE CITY

2000 1000 0 2000 4000

Scale in Feet

U.S. Environmental Protection Agency
Region IV Atlanta, Georgia

II-19-a

FIGURE II-9

MAMMOTH CAVE AREA
201 FACILITIES PLAN

ENVIRONMENTAL IMPACT STATEMENT

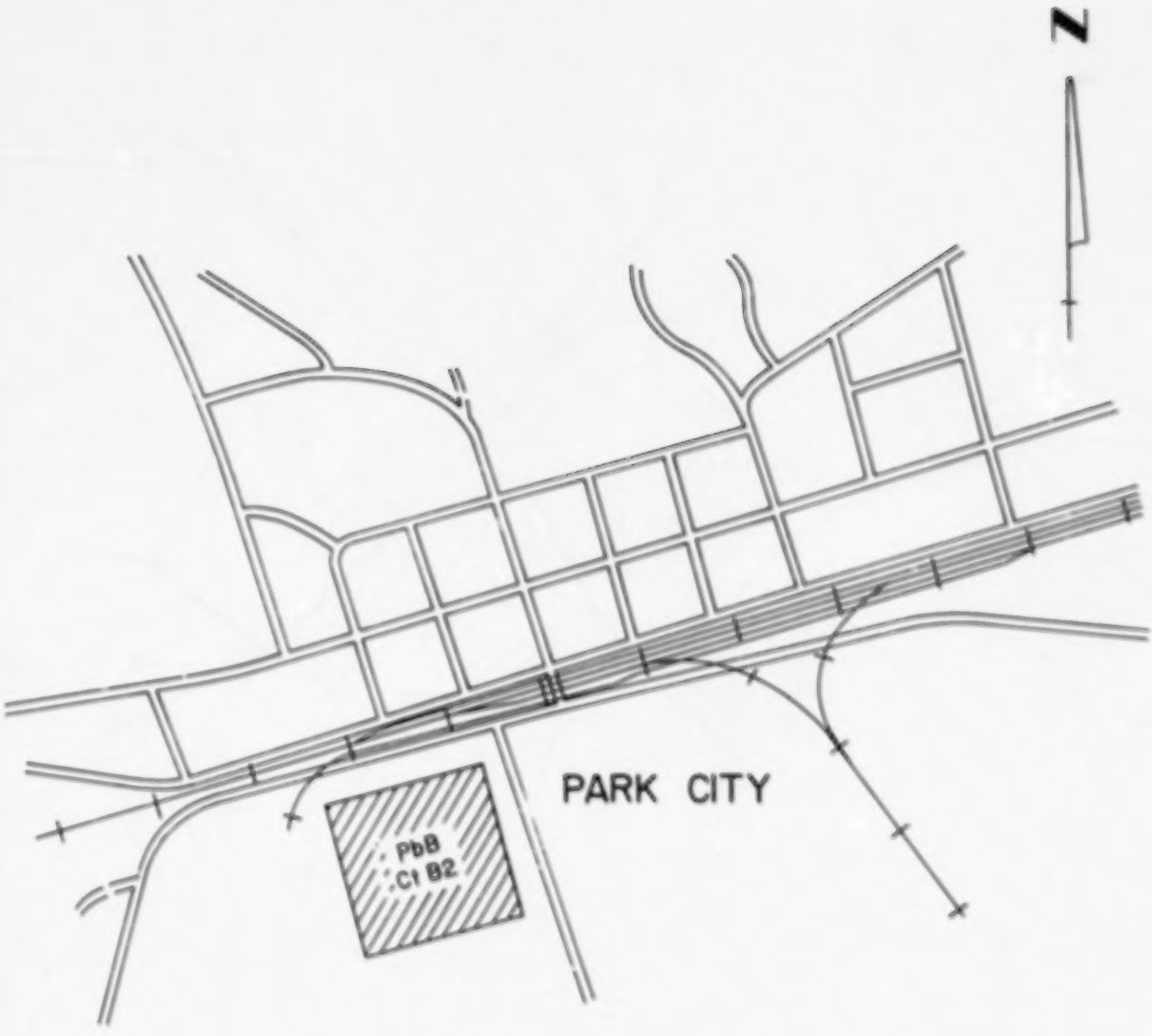
POTENTIAL SLOWRATE LAND APPLICATION SITE–CAVE CITY

2000 1000 0 2000 4000

Scale In Feet

U.S. Environmental Protection Agency
Region IV Atlanta, Georgia

FIGURE II-10



MAMMOTH CAVE AREA
201 FACILITIES PLAN

ENVIRONMENTAL IMPACT STATEMENT

POTENTIAL SLOWRATE LAND APPLICATION SITE – PARK CITY

600 300 0 600 1200

Scale In Feet

U.S. Environmental Protection Agency
Region IV Atlanta, Georgia

FIGURE II-11

TABLE II-5 GENERAL SOIL ASSOCIATIONS/SOIL SERIES IN THE PARK CITY, CAVE CITY AND HORSE CAVE AREAS

Soil Association Soil Series	Permeability Inches/Hr.	Slopes	Depth to Bedrock (feet)	Runoff	Seasonal High Water Table
Cumberland-Pembroke					
Cumberland	Moderate 0.62-2.00	2-20%	5-10	Med.-Mod. Rapid	None
Pembroke	Moderate 0.63-2.00	0-12%	5-10	Slow-Med.	None

TABLE II-6 *SOIL SERIES AT POTENTIAL SPRAY IRRIGATION SITES

Potential Spray Irrigation Site	Soil Identification	Description	Slopes	Potential Limitation to Spray Irrigation
Park City	PbE	Pembroke silt loam	2-6%	Generally Suitable
	CtB2	Cumberland cherty silt loam	2-6%	Generally Suitable
Cave City (Sites A, B, & C)	CtB2	Cumberland cherty silt loam	2-6%	Generally suitable
	CtC2	Cumberland cherty silt loam	2-12%	Slopes
Cave City (Site D)	CrB	Crider silt loam	2-6%	Generally Acceptable
	CtB2 (described above)			
	CtC2 (described above)			

Horse Cave (No soils maps are available for the Horse Cave area (Hart Co.). Based on the general soil associations and the soils trends indicated on the Barren Co. maps, the Horse Cave site probably has CtC2 and CtB2 soils

*Based on Barren County Soils Maps

TABLE II-7 LOCAL WASTEWATER TREATMENT AND DISPOSAL OPTIONS

Population Center	Option Identification	Description of Treatment	Disposal Method and Location	Reason for Further Evaluation
Park City	PC-1	Secondary treatment	Spray irrigation land application system; south of business district of Park City	Provides for centralized treatment/ disposal facilities to serve Park City. Local disposal eliminates conveyance costs
Park City	PC-2	Septic tank/soil absorption systems. Individual systems to serve homes and business establishments which presently discharge directly to the ground water; community soil absorption systems where individual systems are not practical	Land application by soil absorption systems in and around Park City	Properly operated septic tanks and soil absorption systems provide a low cost, low energy use solution to wastewater treatment. There are no conveyance costs and minimal collection costs. No large, single volume of wastewater is discharged directly to the groundwater
Diamond Area	DA-1	Composting, waterless toilets. Septic tank/soil absorption field for greywater from handwashing	Land spreading of composted wastes. Soil absorption field for greywater	Relative to other systems, costs for construction and operation are low. This system provides for water and energy conservation and eliminates any need for conveyance facilities through the National Park
Cave City	CC-1	Advanced secondary treatment; Class I reliability; new facility	Discharge to subsurface waters at existing site in the Hidden River Cave system	Advanced secondary treatment appears to be adequate to protect water quality in the Hidden River Cave system. The system provides for use of existing facilities
Cave City	CC-2	Secondary treatment; Class III reliability (adequate dilution during wet season)	Land application during dry months and subsurface discharge at existing site during wet months	This plan eliminates discharge of wastewater to subsurface under base flow conditions and reduces the costs of Class I reliability secondary advanced wastewater treatment
Cave City	CC-3	Advanced secondary treatment (Class I reliability); upgraded existing facilities	Discharge to subsurface waters at existing site in Hidden River Cave system	This provides a potential least cost solution for Cave City and provides for improved treatment using existing facilities
Horse Cave	HC-1	Advanced secondary treatment (Class I reliability); updated existing facilities; equalization of industrial wastewaters	Discharge to subsurface in Hidden River Cave system downstream from the confluence of the East and South branches	This appears to provide a potential least cost local alternative
Horse Cave	HC-2	Secondary treatment (Class III reliability); updated existing facilities; equalization of industrial wastewaters	Land application at Horse Cave during dry months and subsurface discharge to Hidden River Cave system downstream from East and South Branch confluence during the wet months	This eliminates discharge to subsurface during critical base flow periods
Horse Cave	HC-3	Advanced secondary treatment (Class I reliability); new facilities; equalization of industrial wastewaters	Discharge to subsurface waters, Hidden River Cave system downstream from the confluence of East and South Branches	This provides a comparison between construction of a new treatment plant and upgrading the existing facilities
Horse Cave	HC-4	Secondary treatment (Class III reliability); upgraded existing facilities; equalization of industrial wastewaters	Surface discharge to the Green River	This appears to represent the most environmentally sound local solution for Horse Cave
Munfordville	MV-1	Secondary treatment (w/no solids handling) for existing service area On-lot systems for sections of community outside the service area	Surface discharge to the Green River Soil absorption systems (conventional & alternate)	The possibility of not expanding the present Munfordville collection system requires further evaluation
Munfordville	MV-2	Secondary treatment (w/ solids handling) for entire Munfordville community	Surface discharge to the Green River	Providing sewerage service to all the Munfordville community should be fully evaluated

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TABLE II-8 JOINT WASTEWATER TREATMENT AND/OR DISPOSAL OPTIONS

Population Centers on Joint Effort	Option Identification	Description of Conveyance and Treatment	Disposal Method and Location	Reason for Further Evaluation
Staging Area Park City Cave City Horse Cave	(SA-PC-CC-HC) 1, 2 & 3	Conveyance of wastewaters: Staging area to Park City to Cave City to Horse Cave Secondary treatment (Class III reliability)	Surface water discharge Green River near Lawler Bend	A regional approach to wastewater treatment eliminates subsurface discharges in the area.
Park City Staging Area (Rt. 70 Development) Cave City Horse Cave	(PC-SA-CC-HC) 1, 2 & 3	Conveyance of wastewaters: Park City to Staging Area to Cave City to Horse Cave. (Rt. 70 development west of Toohey Ridge to Staging Area, east of Toohey Ridge to Cave City) Secondary treatment (Class III reliability)	Surface water discharge to Green River near Lawler Bend	Not only does this regional approach to wastewater treatment eliminate subsurface discharges in the area, but this option provides service to the Rt.70 development area between Cave City and the Staging Area.
Park City Cave City Horse Cave	(PC-CC-HC) 1, 2 & 3	Conveyance of wastewaters: Park City to Staging Area to Horse Cave Secondary treatment (Class III reliability)	Surface water discharge to Green River near Lawler Bend	This provides separation of municipal and National Park alternatives (ease of administration) and still provides for elimination of municipal subsurface discharges.
Staging Area (Rt. 70 Development) Cave City Horse Cave	(SA-CC-HC) 1, 2 & 3	Conveyance of wastewaters: Staging Area to Cave City to Horse Cave (Rt. 70 Development west of Toohey Ridge to Staging Area, east of Toohey Ridge to Cave City) Secondary treatment (Class III reliability)	Surface water discharge to Green River near Lawler Bend	This provides for elimination of Cave City - Horse Cave subsurface discharges and provides for service to the Staging Area and Rt. 70 development. If Park City chooses local treatment, this appears to be an environmentally favorable method for handling the additional population centers.
Cave City Horse Cave	(CC-HC)1	Conveyance of wastewaters; Cave City to Horse Cave Secondary treatment (Class III reliability)	Subsurface discharge to Hidden River Cave downstream from the confluence of the East and South branches	Provide a baseline cost estimate for minimum treatment for Cave City-Horse Cave.
Cave City Horse Cave	(CC-HC) 2, 5 & 7	Conveyance of wastewaters: Cave City to Horse Cave Secondary treatment (Class III reliability)	Seasonal discharge methods. Spray irrigation at Horse Cave during dry months. Subsurface discharge to Hidden River Cave downstream from the confluence of the East and South Branches during wet months	This provides a cost comparison, land application vs. conveyance to Green River. Option still provides for elimination of subsurface discharge during base flow.
Cave City Horse Cave	(CC-HC) 3, 6 & 8	Conveyance of wastewaters: Cave City to Horse Cave Secondary treatment (Class III reliability)	Surface water discharge to Green River near Lawler Bend	This disposal option provides a means for eliminating the largest municipal subsurface discharges.
Cave City Horse Cave	(CC-HC) 4	Conveyance of wastewaters: Cave City to Horse Cave Advancedsecondary treatment (Class I reliability)	Subsurface discharge to Hidden River Cave downstream from the confluence of the East and South Branches	Advanced secondary treatment (Class I reliability) is compared with conveyance to Green River or seasonal spray irrigation.

TABLE II-8 (Cont'd.) JOINT WASTEWATER TREATMENT AND/OR DISPOSAL OPTIONS

Population Centers in Joint Effort	Option Identification	Description of Conveyance and *Treatment	Disposal Method and Location	Reason for Further Evaluation
Park City Cave City	(PC-CC) 1	Conveyance of wastewaters: Park City to Cave City Secondary treatment (Class III reliability)	Seasonal discharge methods: Spray irrigation at Cave City during dry months. Subsurface discharge at existing Cave City site during wet season	This provides a comparison for spray irrigation and advanced secondary treatment and eliminates Cave City base flow discharge.
Park City Cave City	(PC-CC) 2 & 3	Conveyance of wastewaters: Park City to Cave City Advanced secondary treatment (Class I reliability)	Subsurface discharge at existing Cave City site	The 201 plan indicates this option is favorable.
Staging Area (Rt. 70 Development) Cave City	(SA-CC)	Conveyance of Wastewaters: Staging Area to Cave City (Rt. 70 development west of Toohey Ridge to Staging Area, east of Toohey Ridge to Cave City) Secondary treatment (Class III reliability)	Seasonal discharge methods: Spray irrigation during dry months. Subsurface discharge at existing Cave City site during wet season	Provides a method for serving the Rt. 70 Development area and Staging Area and eliminates Cave City base flow discharge.

* Treatment refers to the treatment level to be attained before discharge or spray irrigation without regard to the method of achieving the treatment. Specific methods are presented in alternatives evaluation and account for the different options with the same treatment. (ex. (SA-PC CC-HC)1, 2 & 3).

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"Reliability Class I — Works which discharge into navigable waters that could be permanently or unacceptably damaged by effluent which was degraded in quality for only a few hours, Examples of Reliability Class I works might be those discharging near drinking water reservoirs, into shellfish waters, or in close proximity to areas used for water contact sports.

Reliability Class II — Works which discharge into navigable waters that would not be permanently or unacceptably damaged by short-term effluent quality degradations, but could be damaged by continued (on the order of several days) effluent quality degradation. An example of a Reliability Class II works might be one which discharges into recreational waters.

Reliability Class III — Works not otherwise classified as Reliability Class I or Class II. Note: Pumping stations associated with, but physically removed from, the actural treatment works could have a different classification from the works itself."

The reliability classification has a significant effect on treatment plant costs since the higher the class of reliability, the more duplication of treatment units and equipment is required. For wastewater treatment options for the Mammoth Cave area the assumed reliability classifications are as follows:

Disposal Method	Wastewater Treatment Plant Reliability	Rationale for Classification
Discharge to Green River	Class III	At 7 day, 10 year low flow, Green River provides dilution in the range of 100:1; water quality should not be degraded by poor effluent quality.
Slow rate land application (spray irrigation)	Class III	Soil systems are considered capable of accomodating severely degraded secondary effluent for extended periods.

Back-up requirements for system components for Reliability Class I and Class III wastewater treatment works as they appear in the EPA buletin are provided in Appendix II. The reliability requirements are the basis for developing different costs for Class I and Class III reliability wastewater treatment plants.

4. IDENTIFICATION OF WASTEWATER COLLECTION SYSTEM ALTERNATIVES

Typical wastewater collection systems are composed of conventional gravity sewers and force mains. Gravity sewers convey wastewater and solids from homes by gravity to central collection facilities for treatment or pumping to higher elevations. The size and slope of gravity sewers is based on carrying the design hydraulic load at velocities sufficient to prevent deposition of solids. For this reason, deep excavations, resulting in high construction costs especially in areas with shallow bedrock, are required in locations where the natural slope is inadequate to maintain sufficiently high velocities. Besides this, deep excavation requires deep manholes, expensive to construct and a hindrance to sewer operation and maintenance (O&M). Another disadvantage is that in hilly terrain, several pump stations may be required.

In both Park City and the unsewered portions of Munfordville, the terrain is very irregular with many small drainage areas due to karst sinks. In addition, shallow bedrock hinders excavation. There are alternative wastewater collection systems that may have an application in these areas. Pressure sewers and vacuum sewers are installed at minimum depths (below frost levels) and conform to the contour of the land, eliminating the need for deep excavation and manholes. (Since there are too few operating vacuum sewer systems to consider this a proven technology, only low pressure sewers are further evaluated).

In the operation of a low pressure sewer system, wastewater from individual or groups of residences and/or businesses is pumped to PVC force mains by two methods. The most widely used method is the grinder pump (GP system). The second method involves treating the wastewater with a septic tank and effluent pumping (STEP system) to the now pressure collection system via a sump pump.

Low pressure sewers are evaluated for possible use in the unsewered areas of Munfordville as well as in Park City as part of the alternative evaluation. Since Cave City and Horse Cave have existing conventional systems, no evaluation of alternative collection systems is performed.

5. IDENTIFICATION OF GENERAL TREATMENT SYSTEM ALTERNATIVES

For the purpose of alternatives development it is not necessary to consider the specific processes to be used in providing secondary or advanced treatment levels. More important in alternatives development is the identification of the level of the treatment to be provided by any given treatment-disposal alternative. However, a general discussion of the types of treatment systems and processes to be further evaluated is appropriate. Since nutrient removal is not presently a *major issue in the Mammoth Cave study area, systems for providing secondary and advanced secondary levels of treatment with respect to BOD_5, suspended solids and ammonia nitrogen are discussed.

Physical-Chemical Systems

Physical-chemical (P-C) process technology has been used for industrial wastewater treatment for decades. P-C methods were originally applied to municipal treatment plants as a tertiary treatment step to improve secondary biological effluent quality. The principal processes included chemical coagulation, filtration, and activated carbon adsorption for residual soluble organics removal. Preceeding the energy crisis, many P-C systems were designed for newly constructed and upgraded municipal plants for raw wastewater treatment. Advantages noted at that time included (1) relatively small land requirement, (2) ability to handle increased hydraulic and organic loadings with stable process performance, (3) system immunity to toxic inputs, (4) sludge disposal through incineration could be coupled with the necessary chemical regeneration steps, (5) reduced odor problems, (6) a virtually reclaimed effluent suitable for water supply supplementation or recreational purposes. Most of these advantages are considered to have little applicability in the study area since (1) land availability is not a constraint, (2) toxic inputs are only a problem in Horse Cave and in the future are expected to be controlled by pretreatment, (3) the small amount of chemical regeneration required makes construction of regeneration facilities economically infeasible, and (4) there is little incentive for using reclaimed wastewater. Since few, if any, advantages could be realized by this type of system and since treatment costs are high per volume treated based on the current economy, no consideration is given to evaluating a purely physical-chemical treatment system.

The possibility of the addition of a tertiary filtration step following secondary biological treatment is considered by the 201 consultant for local disposal at Park City and for discharge to the Green River from Horse Cave. This physical process may be added at a later date if required. At this time, however, it does not appear necessary. For treatment/disposal options involving upgrading existing plants or construction of new treatment facilities biological treatment systems are considered adequate.

Biological Wastewater Treatment Systems

Biological wastewater treatment systems used for secondary treatment of municipal wastewaters generally consist of solids removal by screening and primary sedimentation followed by a biological process which uses a mixed culture of micro-organisms to convert organic wastes to cellular material by

*There is same concern regarding nitrate levels in subsurface waters that may be used as drinking supplies since baseflow sampling data indicate a nitrate nitrogen concentration in L&N Cave of 10 mg/l (NO_3 as N), the limit for raw drinking water. However, the level in heavily polluted Hidden River Cave ranges between 3 mg/l at Gorin Min to 5.5 mg/l in the South Branch. Denitrification doesn't appear to be a consideration at this time, however.

biochemical oxidation. The excess cellular material is removed by sedimentation following the biological treatment process, generating a waste sludge which must be stabilized and disposed. Advanced levels of treatment (futher BOD_5 reduction and nitrification) may be accomplished by the addition of a second biological process unit.

There are two types of biological processes used in these treatment steps, suspended growth process (e.g. various activated sludge processes) and fixed growth processes (e.g. trickling filters and rotating biological contractors). Suspended growth or fixed growth processes may be used separately or in combination to provide secondary or advanced levels of treatment. The specific processes to be used to accomplish levels of treatment required by different alternatives are selected in the alternatives evaluation. The selections are based on the following criteria:

1) Process reliability
2) Mechanical reliability
3) Operational Ease
4) Energy Consumption
5) Process stability
6) Design flexibility
7) Construction and operating costs

6. NON-STRUCTURAL WASTEWATER MANAGEMENT SYSTEMS

Optimum Use of Existing Facilities

As indicated in the 201 Facilities Plan draft, the towns of Horse Cave, Munfordville and Cave City have substantial investment in their respective wastewater treatment facilities. Therefore, consideration should be given to maximizing use of these existing facilities in future wastewater treatment plans. Optimum use of existing facilities as a non-structural alternative generally implies optimizing plant operations (to provide adequate treatment) as an alternative to new construction. However, this discussion of optimum use deals with maximizing use of the existing facilities in the Mammoth Cave study area to minimize construction of new facilities since none of the existing wastewater treatment plants are considered adequate to handle future wastewater flows and loadings with only operations improvements.

Munfordville Wastewater Treatment Plant - All alternative service configurations developed for the study area provide for local wastewater treatment and disposal at Munfordville. The existing Munfordville sewerage system only serves approximately half of the Munfordville area. Expansion of this system is one of the two wastewater treatment/disposal options considered. However, the Munfordville year 2000 wastewater flow projection of 120,000 gpd is for the entire Munfordville area, indicating that even if the system is expanded, the existing 150,000 gpd extended aeration facility appears to be adequate to continue to serve the area. The 150,000 gpd capacity also provides some reserve hydraulic capacity for infiltration/inflow. Both options, therefore, provide for full utilization of the existing Munfordville plant to provide secondary treatment. However, some improvements are necessary for future operations as indicated by the 201 Facilities Plan draft. These include disinfection facilities and, if wastewater loads approach design capacity, solids (sludge) handling facilities.

Cave City - According to the 201 Facilities Plan draft, even with optimum performance, the existing Cave City treatment plant is only expected to be capable of producing an effluent BOD_5 of approximately 50 ppm due to strong influent waste loads. Since the plant is incapable of meeting even secondary treatment levels, use of the plant to provide complete treatment is not considered a viable alternative. However, as given in the 201 Facilities Plan draft, there are three alternative uses which should be considered. They are as follows:

1) Use of the clarifiers as wet-wells, and aeration and chlorination basins for pre-treatment before pumping.
2) Operating the existing facilities to maximum potential and pumping the effluent to a central facility for additional treatment and disposal.
3) Operating the existing facilities to maximum potential and adding an additional treatment step at the present site.

Horse Cave - Information in the 201 Facilities Plan draft indicates that even with adequate industrial pre-treatment, plant repairs and optimum operations, the existing facilities at Horse Cave are only capable of

producing an effluent BOD_5 concentration of approximately 40 ppm which exceeds secondary treatment standards. Therefore, as in the case of the Cave City plant, use of the existing facilities to provide complete treatment is not considered a viable alternative. There are, however, alternative uses which are to be further evaluated:

1) Operating the existing facilities (with repairs and industrial pre-treatment) to maximum potential and pumping the effluent to a joint treatment facility for additional treatment and disposal.
2) Operating the existing facilities (with repairs and industrial pre-treatment) to maximum potential as part of an upgraded plant to serve Horse Cave.

Flow and Waste Reduction

An important non-structural technique that can be employed in water quality management is the use of water conservation and flow reduction techniques. Obviously, if less water is used, a reduced volume of wastewater is produced which costs less to treat. Where a wastewater treatment plant is already overloaded, a reduction in wastewater flows could significantly improve wastewater treatment.

The reduction of flows could have several effects upon a community's wastewater system. First, treatment could be improved with reduced flows. Secondly, the community could possibly avoid the cost of constructing a new or expanded treatment plant with the reduction of flows into the existing plant or prolong the design life of plants presently being designed or constructed. There seems to be a growing emphasis throughout the country on water conservation. Recent droughts in many sections of the United States have focused attention upon both the problems and the measures that can be taken for water conservation and flow reduction.

Per capita water consumption throughout the Mammoth Cave study area is near or below average* when only considering residential and non-motel commercial water consumption. Estimated 1980 per capita consumption in the four municipalities is as follows (based on data in Appendix II):

Park City - 50 gpcd
Cave City - 60 gpcd
Horse Cave - 50 gpcd
Munfordville - 60 gpcd

It is unlikely that these demands can be substantially reduced. However, estimates of future per capita consumption used in developing water consumption projections (Appendix I) do not reflect the traditional rate of increase, but rather increase more slowly in an attempt to account for conservation trends. The methods for reducing flows outlined in this section may be employed to maintain existing per capita consumption (residential and non-motel commercial).

Flow reduction techniques are expected to have a significant impact on motel and tourist-related commercial water consumption as well as industrial

*Comparison of estimated per capita consumption with normal water consumption figures - Fair, Geyer and Okun, Water Supply and Wastewater Removal, Vol. 1, pp. 5-13, 1966.

water consumption where controls may result in substantial economic benefits. In the towns of Cave City and Horse Cave, residential and non-motel commercial consumption in the summer months is less than one-half the total water consumption. This situation is expected in Park City as tourism grows. Major reductions in water demands could prolong the design life of planned wastewater treatment facilities to serve these areas.

There are several flow reduction alternatives available that would be suitable for use in the Mammoth Cave area. These include:

1. Water Use Reduction
   - Plumbing Codes
   - Flow Control Devices
   - Educational Programs
2. Water and Wastewater Pricing
3. On-Site Disposal of Wastewater

A review and discussion of all of these techniques that are available for reducing flows is provided in Appendix II. Water reduction techniques are presented not as an alternative to wastewater treatment plants, but to indicate methods that might be used in the area to slow increased per capita consumption.

Land Use and Development Controls

Increases in permanent population in the study area and increases in tourism and related facilities have had and will continue to have significant impacts on water quality in the area. As population increases, rural land is converted for an assortment of land uses such as residential, commercial industrial, and street and highway uses. This generates increased stormwater runoff which may significantly impact subsurface water quality depending on the type and location of development. In addition, wastewaters generated by this new development must be assimilated by a limited land and water system.

Land use controls which provide for some order to development may limit potential adverse impacts on water quality (and other environmental amenities) from uncontrolled growth. Limiting the size of motels and/or campgrounds in areas where subsurface discharges of wastewater might severely impact cave waters is one example of a specific application of this type of control in the Mammoth Cave area.

Land use controls are also important in areas of interceptor construction. Many times a cost-effective method of transporting wastewaters is abandoned for fear of uncontrolled growth near the interceptor line, especially if the interceptor is to pass through an environmentally sensitive area. This is not a very satisfactory approach to land use planning since the decision on interceptor location is actually determining the area of development. An effective land use program could end this type of indirect decision making by placing the land use decisions directly in the hands of local governments.

In order to effectively plan and manage land use there are a variety of land management tools and techniques that are available to the various

counties and municipalities and the study area. Because effective land use planning is considered to be so important to assuring reasonably environmentally sound development in the Mammoth Cave area. Descriptions of such techniques are provided below.

Comprehensive Plans - The comprehensive plan is the basis and foundation upon which all development controls should be established. The comprehensive plan provides a complete framework for community development. A good plan would set forth community development goals and objectives, a land use plan, transportation plan, community facilities plan, an evaluation of environmental considerations, and the communities relationship to the region and to adjacent communities.

Zoning Ordinances - The zoning ordinance is a significant tool for implementing the comprehensive plan of a community. Zoning is an exercise of the municipalities inherent power to exercise reasonable control over property and persons under its jurisdiction. Under zoning, the municipality is divided into districts, each district having regulations governing its permitted uses. Zoning attempts to promote and coordinate overall community development as well as protect the general welfare of the community.

Subdivision and Land Development Regulations - Subdivision regulations are designed to regulate the division of land into smaller parcels. Land development ordinances control the improvement of land for any purpose, including structures, streets or other features. Both techniques are intended to allow for public control over the impacts of converting raw land into building sites.

Planned Residential Development (PRD) - A planned residential development is an area of land developed under a single master plan for a number of dwelling units of various types. The development plan for a planned residential development does not correspond in lot size, bulk or type of dwelling, density, lot coverage and required open space to the regulations established in any one residential district of a municipal zoning ordinance. The purpose of the PRD is to encourage innovations in residential development so that the growing demand for housing can be met by a greater variety and type, design, and layout of dwellings, together with the conservation and more effecient use of open space.

Easements - Positive and negative easements are techniques by which a permanent interest in land can be acquired. Governments, individuals and organizations may obtain positive easements in order to establish the legal right to use part of another's private land for certain limited and stated purposes. Negative easements permanently limit the uses to which an owner may put his land, but such easements do not provide for public use. For example, the purchase of conservation easements would limit development in critical areas such as woodlands, rugged terrain, flood plains, open space and areas with drainage to sensitive cave systems.

Fee Simple Acquisition of Land - The outright acquisition of land can be accomplished through several means. Purchase of the property can be made through negotiations with a willing owner and then leased back or rented to the former owner for a set period of time. Tax delinquent land could also be purchased at auction. Similar acquisitions can be made of land upon which there is a mortgage in default of payments. Gifts

of land are also possible from citizens, groups, and corporations to municipalities, conservancies, and other organizations.

In addition to the land use and development control techniques that are currently in use or proposed for use in the study area, there are several other control techniques that should be considered for possible use in the study area.

Staged Growth Policies - Under such policies the amount of land zoned for development is based upon the reasonable development needs of the community and its region. With these policies, the installation of public facilities and provision of public services can be phased more efficiently. Of course the use of staged growth policies will rely upon the development of a comprehensive plan and a land use plan for accommodating future growth of the municipality. The zoning ordinance in the municipality should be compatible with the land use plan and should include only enough residential, commercial and industrial zoned land to meet the growth needs of the community for the next five to ten year period. Staging of growth will allow compatibility with available supporting services and facilities such as public water and sewers, roadways, schools and recreational facilities.

Conservation Zoning District - These types of areas should be established for control and limit development in areas where physiographic problems exist such as steep slopes, accessibility is difficult or the area is of outstanding natural beauty or environmental value. These areas might be appropriated for uses such as forestry, recreation, agriculture and perhaps even some low density residential development.

Model Zoning Ordinances - The field of land use controls and in particular zoning is one in which there are constant changes in techniques, demands and legal constraints. Since many existing zoning ordinances do not take into account the most recent environmental concerns or landmark court decisions, there is a need for constantly up-to-date information on zoning and the provision of modeling zoning ordinances.

Industrial Wastewater Management

There are only two significant sources of industrial wastewaters in the study area, Ken Dec, Inc. (electroplating) and Hart County Creamery, Inc. (cheddar cheese and cheese by-products). Descriptions of these industries and wastewaters are provided in the Environmental Inventory, pages (I-151) - (I-158) as well as in the 201 Facilities Plan draft. Industrial wastewaters from both are presently discharged to the Horse Cave wastewater treatment system.

The adverse effects of these industrial wastewaters on operations at the Horse Cave treatment plant are well-documented. Electroplating wastewaters, which account for approximately one half of the total hydraulic load to the plant, have been toxic to the biological processes because of their high (and variable) concentrations of heavy metals and pH extremes. Low pH levels are suspected as the cause of damage to plant equipment. Wastewaters from the cheese and whey plants of Hart County Creameries also adversely affect the biological processes by discharging wastewaters with extreme pH variations, caused by the use of acid and alkali cleaners for

washdown and also the acidic nature of some whey wastes. In addition, spills and washdown result in temporary discharges of extremely high BOD which also may adversely affect the biological processes. Since both of these facilities are located near the treatment plant, there is little dilution of industrial wastewaters before entering the plant.

The 201 Facilities Plan draft provides specific recommendations for minimizing the adverse effects of the industrial wastewaters on the Horse Cave treatment plant. These recommendations call for action on the part of Ken Dec, Inc. and Hart County Cremery, Inc. as well as the town of Horse Cave.

Horse Cave - The 201 Facilities Plan draft recommends two immediate steps with respect to industrial wastewater management which should be taken to improve present plant operations. These are generally as follow:

1) Install a recording pH meter with an alarm system for monitoring the plant influent
2) Negotiate with Ken Dec, Inc. to obtain an agreement for providing improved and more consistent pre-treatment operations
3) Pass an interim use ordinance to limit the metals in industrial discharges as follows:

	Recommended Standard
Total Chromium	1 ppm
Hexavalent Chromium	.25 ppm
Copper	.2 ppm
Nickel	1.0 ppm
Zinc	.2 ppm
pH	6.5-9 ppm
Suspended Solids	-
Total Cyanide	0.2 ppm
Free Cyanide	-
Total Metals	2.5 ppm

The 201 Facilities Plan draft also recommends that the City of Horse Cave construct a 24-hour aerated equalization basin for Ken Dec's process wastewaters as further protection against upsets due to toxic metals or pH fluctuations. Wastewater from the basin would by-pass the existing secondary treatment facilities and be treated in a final step either at local or joint treatment/disposal facilities. This plan not only assures at least some consistent treatment, but provides for using the existing facilities as a first treatment step without hydraulically overloading, by-passing the Ken Dec wastewaters.

Ken Dec, Inc. - Essentially, the 201 Facilities Plan draft recommends improved operations of the Ken Dec pretreatment facilities to meet more stringent standards than required by EPA pre-treatment. This is because Ken Dec's wastewaters receive only 1:1 dilution with non-metal bearing wastes. The 201 draft indicates that even if the EPA pre-treatment standards are met, concentrations of some metals after this small dilution will

remain high enough to be toxic to some biological treatment processes based on results of toxicity studies published by the EPA.

It is indicated in the 201 Facilities Plan draft that although a treatment system may be capable of providing adequate pre-treatment, human error (e.g. spills and poor plant operation) and/or equipment failure require that measures be taken to make pre-treatment as fail-safe as possible. (This is because a brief failure may disrupt Horse Cave treatment plant operations for months.) Recommended steps to be taken by Ken Dec include:

1) Diversion of wastes to a temporary holding basin in case of spill or lapse in the pre-treatment process
2) Provisions for additional treatment of improperly treated wastes that reach the basin.

Hart County Creamery, Inc. - The 201 Facilities Plan draft recommendations regarding wastes from the Creamery's cheese and whey plants call for improved pre-treatment. These recommendations are generally as follows:

1) Install an aerated equalization basin for cheese plant wastes holding a minimum of 25,000 gallons to be discharged over a minimum of a 18-hour period.
2) Install better curbing around loading and unloading areas and pipe wastes and spills from these areas to equalization facilities.
3) Install recording pH meters with alarms on equalization facilities at both the cheese and whey plants.
4) Install automatic pH adjustment at the whey plant equalization facility.
5) Pipe drains from the whey plant loading platform to the proposed cheese plant equalization basin.
6) Make provision for storing spills in the equalization basin by temporarily by-passing the equalization basin.

This EIS is in general concurrence with the findings and recommendations for industrial wastewater management contained in the 201 Facilities Plan draft. There are some additional comments and recommendations that appear appropriate.

Adoption of a stringent and enforceable sewer use ordinance is necessary for protection of public wastewater facilities. This should cover all potential wastes which may be discharged to the Horse Cave wastewater collection. The recommendation in the 201 draft for adoption of an interim use ordinance to limit metals discharge is, therefore, considered to be a recommendation for an immediate temporary action before a complete ordinance is prepared and adopted.

The method for determining the limits for metals discharge in the proposed use ordinance is generally appropriate in that standards are set based on potential toxicity to treatment processes. The specific limit for each metal is determined based on the minimum concentration in which that metal may be toxic to aerobic processes (for carbonaceous BOD removal), anaerobic processes or nitrifaction processes, the toxic concentration for the process most sensitive to that metal serving as the basis. In the case

of copper and zinc the proposed pre-treatment standard is 0.2 mg/l, five times more stringent than the design standards of the Ken Dec pre-treatment facility. This standard is based on toxicity levels for nitrification processes. Since it is uncertain whether nitrification processes will be necessary for treatment of Horse Cave wastewaters, it may be more appropriate to determine interim limits for these metals based on toxicity to aerobic or anaerobic processes until nitrification processes are included in the Horse Cave treatment system.

In the 201 Facilities Plan draft, particular emphasis is placed on Ken Dec, Inc. providing a fail-safe treatment system. To help protect against spills and operations problems, a holding basin and additional treatment is recommended. In addition to these steps, it is recommended that a spill and accident prevention plan be developed by Ken Dec. Such a plan should include at a minimum: 1) an inventory of all potential areas where spills could reach the wastewater collection system, 2) a description of safety measures which could be instituted to help prevent spills and 3) an emergency plan of action for spill cleanup. After completion, positive preventive measures developed in the plan should be instituted and employers sufficiently instructed regarding the serious nature of the problem as well as the preventive and emergency measures to be used in case of spills.

In addition to providing adequate pre-treatment, it is also recommended that Ken Dec, Inc. investigate methods for re-use of process wastewaters. Although wastewater projections for design do not include provisions for water use reduction, Ken Dec has indicated plans to reduce consumption by as much as 40% in the future. Such a reduction would not only reduce the impact of industrial wastewater discharges, but prolong the life of the treatment facilities.

The 24-hour equalization basin recommended in the 201 draft affords still another protection against metals and pH toxicity. The recommended method of transporting waste to the basin in the 201 draft, however, is unclear. One possibility mentioned is piping the wastes from the existing Rt. 31W interceptor in front of Ken Dec to the basin. This would include wastewaters from the Caverna Hospital and several households, and appears to be unsatisfactory. It is recommended, therefore, that the wastes pumped to the basin be entirely industrial, requiring a force main to pump wastes directly from Ken Dec to the basin. Such a force main is indicated in Exhibit IV G-1 in the 201 Facilities Plan draft but is not fully explained in the discussion of industrial wastewater pre-treatment.

Because the proper handling of industrial wastewater is considered to be so vital to successful wastewater treatment plant operations, the 24-hour equalization basin and industrial force main and pumping station are included as part of all wastewater treatment and disposal options involving Horse Cave that are evaluated in this EIS. It is assumed that these facilities will be constructed and maintained by the city of Horse Cave in order that they assure control of non-organic industrial wastewaters that enter the municipal wastewater treatment system.

MAMMOTH CAVE AREA, KENTUCKY

201 FACILITIES PLAN

ENVIRONMENTAL IMPACT STATEMENT

APPENDIX II

ALTERNATIVES DEVELOPMENT TECHNICAL

REFERENCE DOCUMENT

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION IV

ATLANTA, GEORGIA 30365

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PART A. RT. 70 DEVELOPMENT WASTEWATER FLOW PROJECTIONS

RT. 70 DEVELOPMENT WASTEWATER FLOW PROJECTIONS

The wastewater flow estimate for the Rt. 70 development area is based on estimated existing water demands and the projected growth rate for the Cave City area. Wastewater flows are assumed the same as water demand projections since there is little data to develop estimates.

Estimated Existing Water Demand

Recently the Green River Valley Water District installed a water line that serves the Rt. 70 development area as well as the National Park. Water demand on this line during peak summer months is projected to be 150,000-200,000 gallons per day * when service is completed. The National Park share of this water is estimated as follows:

Assuming 1979 peak demands are similar to August 1970 peak demands use the 1970 data.

Great Onyx Job Corps Center	42,000 gpd
National Park Concessions	38,000 gpd
National Park Service	90,000 gpd
TOTAL	170,000 gpd

Assuming the Job Corps Center only uses about 10,000 gpd at present reduced staffing, total National Park demand will be approximately 138,000 gpd.

o°o Rt. 70 demand = 175,000 gpd - 138,000 gpd = **37,000 gpd

Projected Water Demand

Assumption: Demand in the Rt. 70 development area increases at a rate similar to that projected for Cave City.

$$\frac{\text{Cave City yr. 2000 Peak Month Demand Projection}}{\text{1980 Cave City Estimated Peak Month Demand}} \times 37{,}000 = \text{Design Demand for Rt. 70 Development}$$

$$\frac{414{,}000 \text{ gpd}}{323{,}000 \text{ gpd}} \times 37{,}000 \text{ gpd} = 47{,}400 \text{ gpd}$$

say 50,000 gpd

* Personal communication with Mr. E. Larimore, Green River Valley Water District

** This estimate has since been confirmed by the Green River Valley Water District (9/11/79). Summer use without service to the National Park is reported to be in the range of 1 million gallons (33,000 gpd).

PART B. ASSIMILATIVE CAPACITY ANALYSIS FOR HIDDEN RIVER CAVE

ASSIMILATIVE CAPACITY ANALYSIS FOR HIDDEN RIVER CAVE

The stabilization of an organic waste in a flowing stream is a complex process that involves several different interdependent physical and biochemical processes. In order to use sophisticated predictive modeling to estimate the assimilative capacity* of a receiving stream, a relatively extensive data base is required. There is no such data base available for the waters of Hidden River Cave. In the absence of extensive data, a simple mathematical relationship may be developed that involves the two most important processes, deoxgenation due to the biochemical oxygen demand exerted by organic wastes and reaeration due to air to water surface contact. The development of the relationship is based on the following assumptions:

- the stream is one dimensional
- only advective transport is considered
- steady state conditions exist
- complete mixing of the stream and waste discharge occurs "instantaneously"
- BOD** degradation occurs according to first order kinetics

Although developed in many different forms in different sources the basic relationship relating maximum dissolved oxygen deficit and BOD concentration in the receiving stream after mixing with the waste discharge can be expressed as follows:

$$***\frac{D_c}{L_o} = (\emptyset)\ \frac{\emptyset}{1-\emptyset}$$

Where D_c = Maximum dissolved oxygen deficit, the difference between the saturation dissolved oxygen concentration and the lowest allowable concentration. In Hidden River Cave, this is estimated to be about 5.2 mg/l; since the saturated dissolved oxygen of cave waters is approximately 10.2 mg/l (15°C) and the minimum allowable concentration is 5 mg/l.

L_o = BOD of the receiving stream after mixing with the wastewater discharge. (for this analysis stream background BOD is assumed to be 2 mg/l.

$\emptyset$ = Ratio of the reaeration constant to the deoxygenation constant.

* The term assimilative capacity in this analysis refers to the amount of organic wastes (in terms of BOD) that the stream may receive and maintain a minimum level of 5 mg/l dissolved oxygen, the aquatic life criterion.

** BOD used in this analysis is ultimate BOD or BODu. This is a combination of carbonaceous BOD (BOD_5) and Nitrogeneous BOD (NBOD) and is expressed as follows $BODu = 1.5\ (BOD_5) + 4.5\ (NBOD)$.

*** This form of the equation is found in Simplified Mathematical Modeling of Water Quality, U.S. Environmental Protection Agency, May, 1972.

The term ϕ is referred to as the assimilative ratio. It is also termed the self purification constant "f" according to Fair, Geyer and Okun*. If adequate data are available ϕ (or f) can be determined for a specific receiving stream. Since no data is available for Hidden River Cave, however, a range of typical values (Table AII-1) can be used to provide an estimate of allowable BOD.

Table AII-1. *Values of the Self Purification Ratio

Nature of Receiving Water	Magnitude of f at 20°C
Small ponds and backwaters	0.5 - 1.0
Sluggish streams and large lakes or impoundments	1.0 - 1.5
Large streams of low velocity	1.5 - 2.0
Large streams of moderate velocity	2.0 - 3.0
Swift streams	3.0 - 5.0
Rapids and waterfalls	>5.0

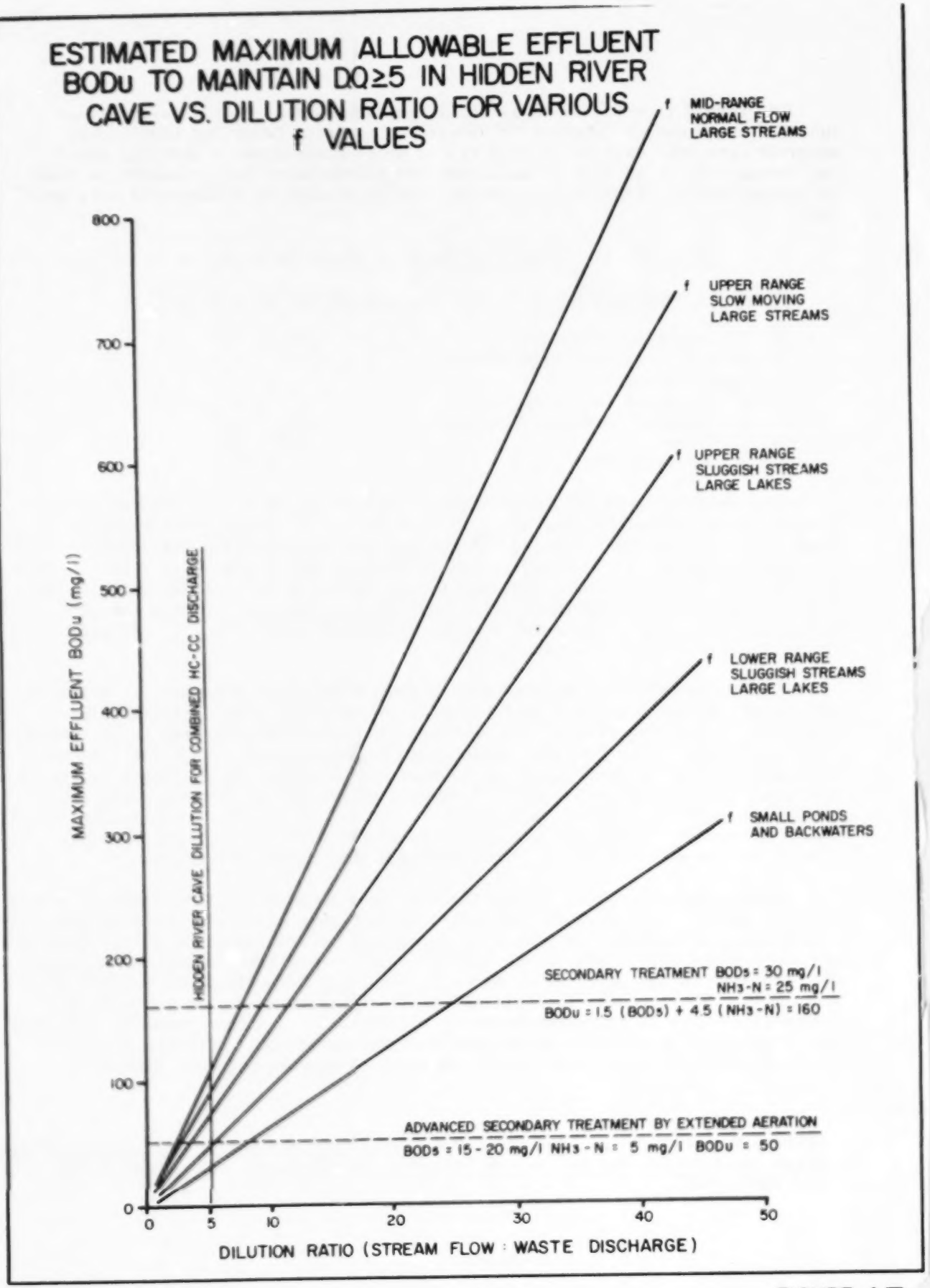
Allowable BOD loadings to maintain dissolved oxygen levels greater than 5 mg/l are provided in Figure AII-1. Those allowable loadings are given for a range of dilutions and f values. The values are obtained from Figure 33-5 "Allowable loading of receiving waters"...in Fair, Geyer and Okun. The f values are based on 20°C. Although cave waters are typically 14° - 15°C, using these f values is considered appropriate for estimating purposes. (Using the 20°C values produces conservative BOD loading allowances since the rate of oxygen uptake is faster in warmer waters).

From Figure AII-1 it appears that advanced secondary treatment is adequate for protecting water quality (with respect to dissolved oxygen) in the Hidden River Cave. The base flow of the combined East and South branches is estimated 7 cfs (4.5 mgd). This provides an approximate dilution of 5 to 1 for the combined design flow of Horse Cave and Cave City (0.9 mgd). As indicated by Figure AII-1, if the cave streams have an f value greater than 1, adequate dissolved oxygen levels will probably be maintained. It is likely that f values for the Hidden River Cave stream are significantly higher since it is a shallow, swift flowing stream where observed. This provides some margin for error.

Another consideration is time of travel and location of the dissolved oxygen critical point. The allowable BOD loadings in Figure AII-1 are based on the assumption that streams continue with no changes or additional dilution. However, in Hidden River Cave there is substantial dilution available between Horse Cave and discharge to the Green River based in the large base flows (25-28 cfs) at Gorin Mill. The time for the critical point of dissolved oxygen to occur in Hidden River Cave is approximated to be 1-2 days. At a stream velocity of 1 fps; this represents 16-32 miles downstream from the discharge. Although distances to the Green River in Cave miles are unknown, it appears possible that water

* Fair, G.M., Geyer, J.C., and Okun, D.A., Water and Wastewater Engineering Volume 2. Water Purification and Wastewater Treatment and Disposal, John Wiley & Sons, Inc., New York, 1968.

ESTIMATED MAXIMUM ALLOWABLE EFFLUENT BODu TO MAINTAIN DQ≥5 IN HIDDEN RIVER CAVE VS. DILUTION RATIO FOR VARIOUS f VALUES



AII-3-a

FIGURE AII

could be discharged to Green River prior to critical oxygen level. Certainly there is, at least, the strong possibility that additional dilution is available within that distance.

It is assumed for this analysis that a combined discharge of Horse Cave and Cave City would occur downstream from the confluence of the East and South Branches. This represents the largest possible single discharge of a BOD load to Hidden River Cave. If the two municipalities continue to discharge separately, the Horse Cave discharge should be moved downstream from the confluence since little dilution is available in the South Branch. In terms of effects of 1300 loading to Hidden River Cave, a separate discharge configuration probably would have even less impact than the combined discharge since some degradation of BOD probably occurs between the Cave City discharge and the East Branch. Therefore, advanced secondary treatment should be adequate for each discharge. Water quality between the Cave City discharge and the East Branch is not considered, however, since the receiving stream characteristics are unknown.

The above analysis should not be interpreted as conclusive in the establishment of effluent limitations. It is based on very rough assumptions and does not account for all the many complex physical and biochemical phenomena that occur in the assimilation of waste materials. However, in the absence of any data, the purification factor method is a useful tool for providing approximate levels of treatment. Advanced secondary treatment is suggested for discharges to the Hidden River Cave system based on the following:

1) Advanced secondary BOD levels appear to be conservative based on the above analysis, providing a margin for error due to the approximate nature of the method.

2) Additional dilution may be available in Hidden River Cave downstream from Horse Cave prior to Green River discharge.

3) Advanced secondary treatment systems (extended aeration) are relatively simple to operate. More advanced levels of treatment are very difficult to operate and may not consistently produce as high a quality effluent as advanced secondary due to operational problems.

4) Since Hidden River Cave is so polluted at the present time, advanced secondary treatment can only vastly improve the water quality. It appears unwarranted to require additional treatment before the stream can reach equilibrium with advanced secondary, especially when indications are that advanced secondary is adequate to protect water quality.

PART C. BOD_5 LOADING IN HIDDEN RIVER CAVE

BOD_5 LOADING IN HIDDEN RIVER CAVE

Based on low flow sampling data, approximately 40 percent of the BOD loading of the combined East and South Branches in Hidden River Cave is derived from the East Branch.

$$.648 \text{ mgd/cfs} \times 1^{*} \text{ cfs} \times 78 \text{ mg/l} \times 8.34 = 422 \text{ lbs/day South Branch}$$

$$.648 \text{ mgd/cfs} \times 6^{*} \text{ cfs} \times 8.9 \text{ mg/l} \times 8.34 = \underline{228 \text{ lbs/day}} \text{ East Branch}$$

$$710 \text{ lbs/day combined}$$

$$\frac{228 \text{ lbs/day (East Branch)}}{710 \text{ lbs/day (combined)}} = 40 \text{ per cent.}$$

*stream flow estimates at base flow conditions

Based on the organic loadings provided by the wastewater treatment facilities at Horse Cave and Cave City, this does not appear to be a reasonable conclusion if the municipal discharges are assumed to be the only major BOD sources. Estimated daily average BOD discharges are developed as follows:

Horse Cave

Average effluent BOD_5 August - September = 265 mg/l
(During base flow sample BOD_5 = 316 mg/l)
Average flow at the Horse Cave treatment plant = 0.34 mgd
Estimated daily average BOD_5 loading contributed by Horse Cave = 750 lbs/day

Cave City

Average effluent BOD_5 January - October 1977 = 65 mg/l
(During base flow sampling BOD_5 = 47 mg/l)
Average flow at the Cave City treatment plant = 0.24 mgd
Estimated daily average BOD_5 loading contributed by Cave City = 130 lbs/day

Based on this additional data, the average daily discharge to Hidden River Cave during low flow sampling was approximately 880 lbs per day. This is substantially higher (24 percent) than the 710 lbs per day estimated by the BOD_5 grab samples and rough flow estimates. (Assuming negligible biodegradation between the Cave City discharge and the East Branch sampling point). Of the 880 lbs/day, only about 15 percent is attributable to Cave City. It is difficult to make any determination regarding BOD loading in Hidden River Cave from the East and South Branches based on the low flow data. BOD samples are only one-time grab samples and stream flow estimates are only approximations. If the East Branch actually contributes 40 percent of the BOD loading to Hidden River Cave, there must be a major source of organic that is unknown at this time. In order to make any definitive conclusion regarding BOD loading in the two branches, long term BOD_5 sampling and accurate streamflow measurements are required.

As stated above, based on existing operating data for the Cave City and Horse Cave plants and assuming that they are the only major sources of organic pollution upstream of the confluence of the East and South Branches, the BOD_5 loading in Hidden River Cave would be approximately 880 lbs BOD_5/day (assume negligible biodegradation between Cave City and the East Branch sampling point). Of this 880 lbs/day approximately 15 percent is attributable to the East Branch (Cave City) and approximately 85 percent to the South Branch (Horse Cave).

PART D. RELIABILITY REQUIREMENTS FOR WASTEWATER TREATMENT SYSTEM COMPONENTS

RELIABILITY REQUIREMENTS FOR WASTEWATER TREATMENT SYSTEM COMPONENTS

Reliability is defined by EPA technical bulletin EPA-430-99-74-001 "Design Criteria for Mechanical Electric and Fluid System and Component Reliability" as, "A measurement of the ability of a component or system to perform its designated function without failure". There are three reliability classifications for wastewater treatment plants developed in the EPA bulletin and are based on the consequencies of potential degradation on the receiving waters. No specific requirements for classifying treatment works are given, however, the following suggested guidelines are presented:

"Reliability Class I — Works which discharge into navigable waters that could be permanently or unacceptably damaged by effluent which was degraded in quality for only a few hours. Examples of reliability Class I works might be those discharging near drinking water reservoirs, into shellfish waters, or in close proximity to areas used for water contact sports.

Reliability Class II — Works which discharge into navigable waters that would not be permanently or unacceptably damaged by short-term effluent quality degradations, but could be damaged by continued (on the order of several days) effluent quality degradation. An example of a Reliability Class II works might be one which discharges into recreational waters.

Reliability Class III — Works not otherwise classified as Reliability Class I or Class II. Note: Pumping stations associated with, but physically removed from, the actual treatment works could have a different classification from the works itself."

Back-up requirements for system components for Reliability Class I and Class III as they appear in the EPA bulletin are provided below. These are the requirements that serve as the basis for developing different costs for Class I and Class III reliability treatment plants.

212.1 Reliability Class I

For components included in the design of Reliability Class I works, the following backup requirements apply.

212.1.1 Mechanically-Cleaned Bar Screens or Equivalent Devices

A backup bar screen shall be provided. It is permissible for the backup bar screen to be designed for manual cleaning only. Works with only two bar screens shall have at least one bar screen designed to permit manual cleaning.

212.1.2 Pumps

A backup pump shall be provided for each set of pumps which performs the same function. The capacity of the pumps shall be such that with

any one pump out of service, the remaining pumps will have capacity to handle the peak flow. It is permissible for one pump to serve as back-up to more than one set of pumps.

212.1.3 Comminution Facility

If comminution of the total wastewater flow is provided, then an overflow bypass with an installed manually- or mechanically-cleaned bar screen shall be provided. The hydraulic capacity of the comminutor overflow bypass shall be sufficient to pass the peak flow with all comminution units out of service.

212.1.4 Primary Sedimentation Basins

There shall be a sufficient number of units of a size, such that with the largest flow capacity unit out of service, the remaining units shall have a design flow capacity of at least 50 percent of the total design flow to that unit operation.

212.1.5 Final and Chemical Sedimentation Basins, Trickling Filters, Filters and Activated Carbon Columns

There shall be a sufficient number of units of a size, such that with the largest flow capacity unit out of service, the remaining units shall have a design flow capacity of at least 75 percent of the total design flow to that unit operation.

212.1.6 Activated Sludge Process Components

212.1.6.1 Aeration Basin

A backup basin shall not be required; however, at least two equal volume basins shall be provided. (For the purpose of this criterion, the two zones of a contact stabilization process are considered as only one basin.)

212.1.6.2 Aeration Blowers or Mechanical Aerators

There shall be a sufficient number of blowers or mechanical aerators to enable the design oxygen transfer to be maintained with the largest capacity unit out of service. It is permissible for the backup unit to be an uninstalled unit, provided that the installed unit can be easily removed and replaced. However, at least two units shall be installed.

212.1.6.3 Air Diffusers

The air diffusion system for each aeration basin shall be designed such that the largest section of diffusers can be isolated without measurably impairing the oxygen transfer capability of the system.

212.1.7 Chemical Flash Mixer

At least two mixing basins or a backup means for adding and mixing chemicals, separate from the basin, shall be provided. If only one basin is provided, at least two mixing devices and a bypass around the basin shall be provided. It is permissible for one of the mixing devices to be uninstalled, provided that the installed unit can be easily removed and replaced.

212.1.8 Flocculation Basins

At least two flocculation basins shall be provided.

212.1.9 Disinfectant Contact Basins

There shall be a sufficient number of units of a size, such that with the largest flow capacity unit out of service, the remaining units shall have a design flow capacity of at least 50 percent of the total design flow to that unit operation.

212.3 Reliability Class III

The Reliability Class I requirements shall apply except as modified below.

212.3.1 Primary and Final Sedimentation Basins

There shall be at least two sedimentation basins.

212.3.2 Activated Sludge Process Components

212.3.2.1 Aeration Basin

A single basin is permissible.

212.3.2.2 Aeration Blowers or Mechanical Aerators

There shall be at least two blowers or mechanical aerators available for service. It is permissible for one of the units to be uninstalled, provided that the installed unit can be easily removed and replaced.

212.3.2.3 Air Diffusers

The Reliability Class I requirements shall apply.

212.3.3 Components Not Requiring Backup

Requirements for backup components in the wastewater treatment system shall not be mandatory for components which are used to provide treat-

ment in excess of primary sedimentation and disinfection, except as modified above. This may include such components as:

Trickling Filter
Chemical Flash Mixer
Flocculation Basin
Chemical Sedimentation Basin
Filter
Activated Carbon Column

PART E. FLOW REDUCTION TECHNIQUES

FLOW REDUCTION TECHNIQUES

Water Use Reduction. Restriction of water use can be very effective in reducing the size of new wastewater facilities. Water use regulations and policies could be adopted by municipalities in the study area which would reduce the flow that is discharged into the wastewater collection system. The most effective regulation would be to amend plumbing codes to require the use of flow reduction plumbing fixtures in all future developments. Plumbing code changes may be especially effective reducing motel consumption.

The following is a list of amendments to plumbing codes that might be considered by a municipality for flow reduction purposes.

-Tank-type toilets for new single-family homes, apartments, rental townhouses, motels, hotels and commercial buildings would be required to be of a design that provides a maximum flush not to exceed three and a half gallons. If a conventional toilet is used, it would be equipped with a water closet reservoir device designed to reduce the flush to three and a half gallons or less.

-Water-saving shower heads to limit flow to a maximum of three and a half gallons a minute would be required in all units. Even without regulations, energy costs for heating water may provide incentive for motels to use these devices.

-Aerators, which result in a flow reduction to approximately four gallons a minute, would be required in all kitchen sinks and lavatories.

-Installation of a pressure reducing valve on the incoming service to all structures would be required for all properties when the incoming water pressure is expected to exceed 60 pounds per square inch. The pressure reducing valve should provide adjustment of the pressure for the household service to within the range of 50 to 60 psi.

-Cellar floor drains may not be connected to the sanitary sewerage system. When floor drains are installed they must be discharged to an approved storm drain. All buildings erected with cellars or basements in areas known to have a water table above the basement floor would be required to have foundation drains around the outside of the building with a satisfactory point of discharge.

The use of water conservation plumbing fixtures throughout the United States has been mostly on a voluntary basis. However, there has been increasing interest in adopting plumbing codes that require the use of one or more water conservation plumbing fixtures. Even without codes, motels may use these types of facilities to cut costs for water. The plumbing fixture industry has reacted to this increasing interest by developing and marketing a large

number of water conservation fixtures that are available to the public. The following is a review of the various water conservation plumbing fixtures that are available.

-Shallow-Trap Toilets - This type of device can be very effective in reducing flows. Each flush of a conventional toilet uses 4-5 gallons of water which is discharged to the collection system. A shallow-trap toilet only uses 2-3 gallons per flush. Shallow-trap toilets are manufacturered by several companies and their cost is not significantly different from that of conventional models.

-Toilet Inserts (Reservoir Replacement) - Approximate savings can range as high as two gallons per flush. Toilet inserts which are available can alter existing toilets so that they discharge only 2-3 gallons per flush. Most toilet inserts are of plastic construction and are easily installed. Because the inserts are inexpensive, municipalities in the study area could consider buying inserts and offering them free to each domestic, institutional and commercial establishment. Other less expensive types of inserts have been used as toilet inserts. These include one gallon plastic milk containers and bricks.

-Toilet Valve Assemblies - This device provides for quick, sure shut-off of the water closet valve when the tank has filled after flushing and is designed to make a noticeable noise when the tank ball is defective.

-Toilet Flush Adaptors (No. 1 and No. 2 Flush Feature) - This appliance provides for the conversion of many toilets to a light-flush or full flush system. When operating properly, the appliance results in a partial release of water from the toilet closet to the bowl when the handle is tripped in the normal way (this is generally satisfactory for removal of liquid waste in the bowl). When a full flush is required the toilet flushing handle must be held down until the water closet is emptied. (This is required for the removal of paper and solids from the bowl).

-Shower Head Controls - Conventional shower heads permit a flow of between 6 to 10 gallons per minute (gpm) while flow-limiting shower heads restrict the flow to between 2.5 to 3.5 gpm, a 70% savings in the amount of wastewater generated by this source.

-Pressure Reducing Valves - Designed for use in areas where pressure at the top of structures may be higher than 80 pounds per square inch. This device provides for the automatic reduction of pressure, resulting in substantial conservation of water.

-Spigot Flow Controls - This type of spigot utilizes flow control aerators which can reduce flows to 1.5 - 3.0 gpm.

Another effective tool for water conservation and flow reduction is the education of the public. Actually this could be the most important tool since it is through the media that much of the public will

become familiar with the wide range of flow reduction devices and techniques that are available to the public. There are a variety of techniques that can serve as a comprehensive educational program.

Handbooks can be developed for homeowners, apartment dwellers and owners of commercial and industrial establishments which would outline the techniques available, methods of installation, manufacturers and approximate cost. Information programs such as slide or movie presentations could also be developed for preparation to civic and schools groups. These presentations could emphasize the importance of flow reduction and its relationship to increasing cost of services, limited availability of wastewater treatment capacity and potential water supply shortage.

Water and Wastewater Pricing. The theory behind water and wastewater pricing as a flow reduction tool is a simple technique. The theory intends that by raising the price, the demand for water service would drop which would reduce the capacity required at the treatment plant.

For larger water consumers, pricing may have a more substantial impact on consumption. All the municipalities in the study area employ graduated water and sewer rate structures which provide for unit cost decreases as consumption increases. Alternative pricing structures include application of a flat rate for consumption above a set amount or application of penalty charges for extremely large consumption. This pricing structure could provide incentive for large industrial customers (e.g. Ken Dec) and large motels to reduce consumption.

An effective sewer use ordinance is also a method for reducing wastewater. Charges for discharge of excessive amounts of wastes from industrial to municipal systems provide incentive for reduced discharges.

On-Site Disposal. Utilization of on-site disposal systems can be a treatment alternative to the construction of collection systems and sewage treatment plants. This can be a preferred type of treatment alternative which provides for a high level of treatment, helps to maintain base flow in surrounding streams, and provides for recharge to groundwater sources. The previous section on treatment and disposal methods contains a discussion of on-site disposal systems and indicates those areas in the study area which have soils suitable for on-site disposal systems. However, site-specific assessments of the soil/groundwater systems would be required to verify the soils suitability for on-lot disposal.

Use of these techniques in Park City and in the unsewered areas of Munfordville is being considered. Another variation of this type of disposal, use of waterless composting toilets, is also being considered for the Staging Area.